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COLUMBIA-NORTH PACIFIC REGION COMPREHENSIVE FRAMEWORK STUDY OF --ETC(U)
AUG 71 L A REED, J SWEENEY, C T NADLER

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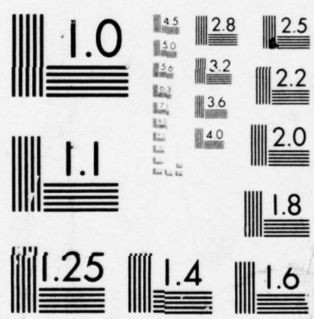

MICROCOPY RESOLUTION TEST CHART
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Columbia-North Pacific Region

Comprehensive Framework Study
of Water and Related Lands

APPENDIX XI

MUNICIPAL & INDUSTRIAL WATER SUPPLY

SUBMITTED BY

PACIFIC NORTHWEST RIVER BASINS COMMISSION
1 COLUMBIA RIVER, VANCOUVER, WASHINGTON

AUGUST 1971

This appendix is one of a series making up the complete Columbia-North Pacific Region Framework Study on water and related lands. The results of the study are contained in the several documents as shown below:

Main Report	Brochure Report

Appendices

I.	History of Study	IX.	Irrigation
II.	The Region	X.	Navigation
III.	Legal & Administrative Background	XI.	Municipal & Industrial Water Supply
IV.	Land & Mineral Resources	XII.	Water Quality & Pollution Control
V.	Water Resources	XIII.	Recreation
VI.	Economic Base & Projections	XIV.	Fish & Wildlife
VII.	Flood Control	XV.	Electric Power
VIII.	Land Measures & Watershed Protection	XVI.	Comprehensive Framework Plans

Pacific Northwest River Basins Commission
1 Columbia River
Vancouver, Washington

(1)

Municipal & Industrial Water Supply

(6) APPENDIX XI

Columbia-North Pacific Region Comprehensive Framework Study of Water and Related Lands. Appendix XI. Municipal and Industrial Water Supply,

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(11) August 1971

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Pacific Northwest River Basins Commission
Vancouver, Washington

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APPENDIX XI
Municipal & Industrial Water Supply

Prepared under the direction of the
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This appendix to the Columbia-North Pacific Region Framework Report was prepared at field level under the auspices of the Pacific Northwest River Basins Commission. It is subject to review by the interested Federal agencies at the departmental level, by the Governors of the affected States, and by the Water Resources Council prior to its transmittal to the President of the United States for his review and ultimate transmittal to the Congress for its consideration.

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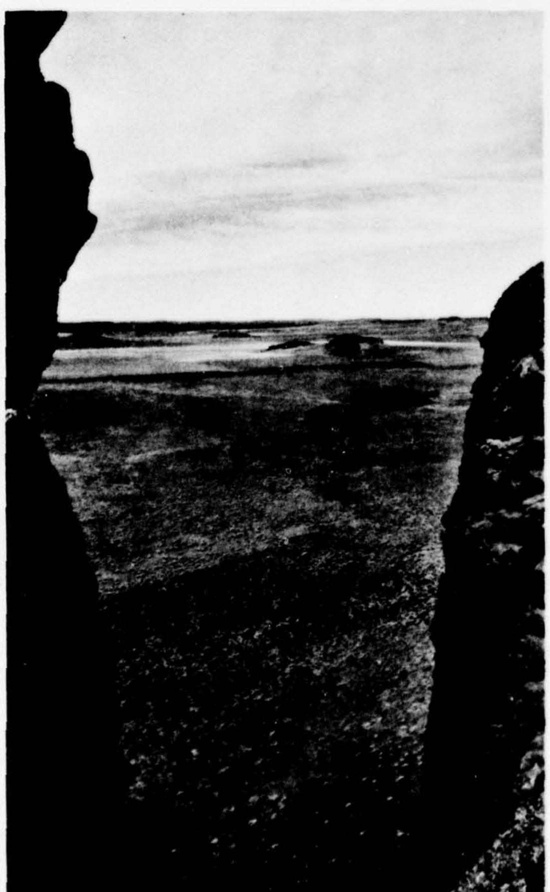


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REGIONAL SUMMARY

R E G I O N A L   S U M M A R Y

INTRODUCTION

The Columbia-North Pacific Region covers about 176 million acres in the states of Washington, Oregon, and Idaho; western Montana; and small portions of Wyoming, Utah, and Nevada. In terms of watershed drainage, it includes that portion of the Columbia River Basin in the United States, Puget Sound, and that part of the Great Basin in Oregon, and the coastal drainages of Oregon and Washington. The major physiographic provinces are the Coast Range, the Puget Sound-Willamette Valley Trough, the Cascade Range, the Columbia Plateau, the Blue Mountains, the Oregon Closed Basin, the Snake River Plain, and the Northern Rocky Mountains.

The climate of the region is primarily continental, with the exception of the strip west of the Cascades, which is relatively warm and humid as a result of the maritime influence. From the crest of the Coast Range, where rainfall exceeds 200 inches, annual precipitation decreases to about 35 inches in the Puget Sound-Willamette Trough, then rises again to 100 inches or more toward the crest of the Cascade Range. In this part of the region, about two-thirds of the year's total falls during the October to March period. East of the Cascade Range, precipitation decreases rapidly to 10 inches or less in the valleys and plateaus. The mountain areas have higher total precipitation of 40 to 50 inches, much of it as snow. The Snake River Plain and the Columbia Plateau experience from 10 to 20 inches of precipitation. Appendix V of this study (Water Resources) was the source of the climatologic and hydrologic information presented in this Appendix and should be consulted when more detail is required.

Almost half of the land area in the region is in forests; over one-third is rangeland; about one-eighth is used for crop or other agricultural land; and less than 5 percent represents municipal, railroad, highways, and other miscellaneous uses. The important land areas which support the more intensive farm and rangelands and major concentrations of population are the Puget Sound-Willamette lowland, the Yakima Valley, the Columbia Plateau, and the Snake River Plain. Smaller valleys such as the Bitterroot, Flathead, and Okanogan in the Cascades and Rocky Mountain areas also support important agricultural concentrations.

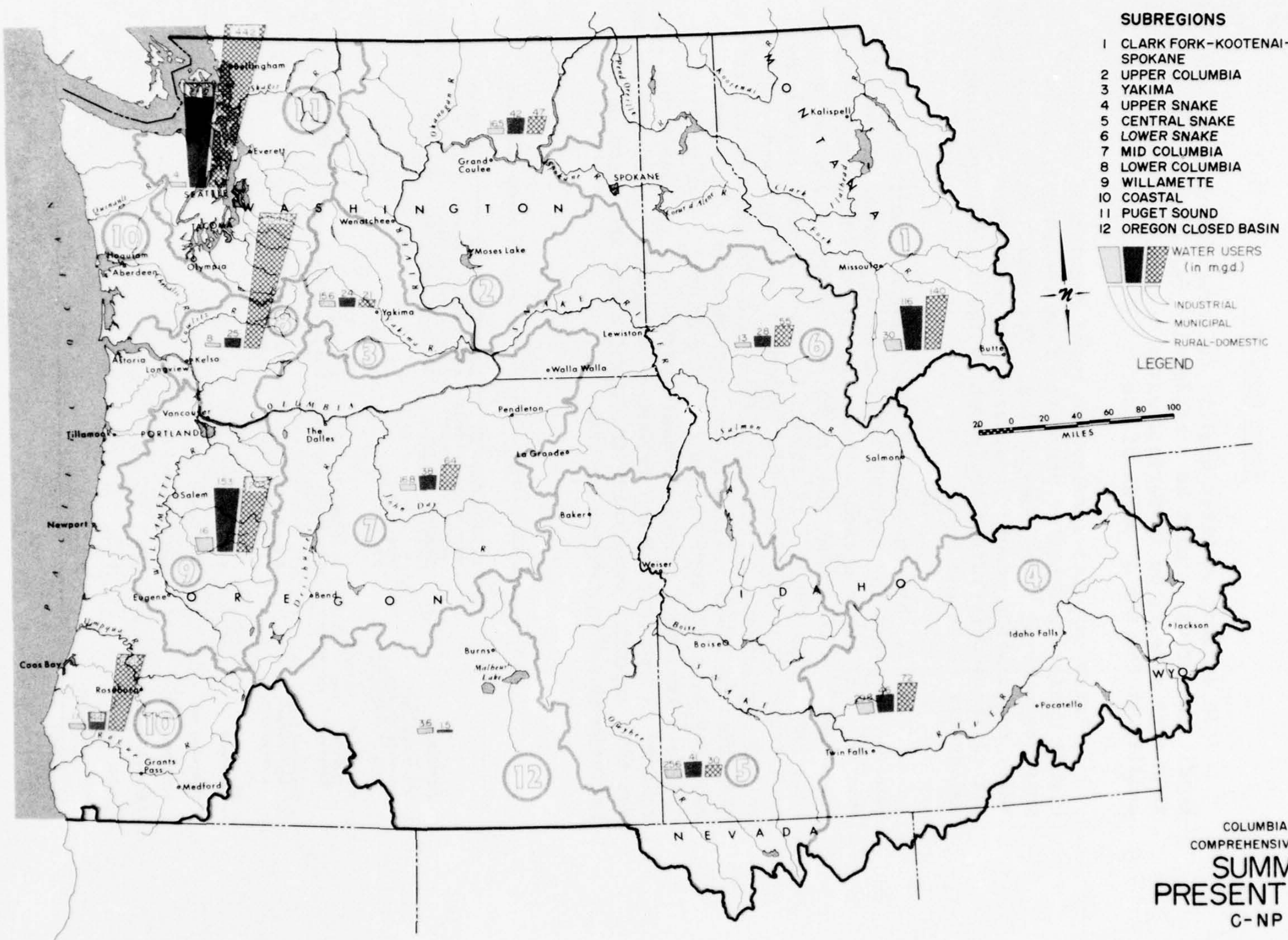
The economy of the Columbia-North Pacific Region has been largely influenced by the development of natural resources. The most important single category of economic development has been

the harvesting of products grown on the land. These products include those from forestry and from agriculture. Lumber and wood products, food and kindred products, and paper and allied products constitute the major classes of manufacturing activity. Transportation equipment is also an important activity due in large part to the Boeing airplane manufacturing operations. The primary metals industry is the next most important industrial activity.

As shown in figure 1, the region is divided for study purposes into 12 subregions delineating major watersheds or groups of watersheds, and in most cases including more than one large stream. Many of these subregions are further divided in terms of subbasins and service areas. (See Glossary of terms in the back of this Appendix). In this study needs were developed for municipal, industrial, and rural-domestic users. Municipal users are considered those in communities of over 250 people served by a centralized water distribution system, less any major industrial users. Industrial users are arbitarily taken as major industries which use significant quantities of water when compared to the municipal users. Rural-domestic users are those not connected to centralized systems serving a population of greater than 250 people. Conditions existing in 1965 were used to determine present water use and are the base for the projection of future needs. Figure 1 is a summary of the present water use for the region.

In interpreting and using the information contained in this Appendix is must be kept in mind that, due to advancing technology and increasing mobility of people and industries, water use patterns in recent years have been changing rapidly. A framework study such as the Columbia-North Pacific Study can only partially account for the detailed effects of these changing patterns. The study was conducted based on information and data presently available, and future needs and problems were determined using the judgment and experience of planners from many agencies. The result is a document which should be reasonably accurate in terms of total regional needs but which may require updating and revisions in specific areas due to localized

In 1965, the population of the region was about 5.9 million persons. Two-thirds of the population lived in the area west of the Cascade Range, which constitutes less than a fourth of the total land area. Approximately 43 percent of the population resided in seven major service areas--Seattle, Tacoma, Everett, Portland, Salem, Eugene-Springfield, and Spokane. The distribution of population by urban, rural, and rural nonfarm classifications has closely followed the national pattern. The trend has generally been an increase in urban, a decrease in rural farm, and an increase in rural nonfarm population.



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

SUMMARY OF PRESENT WATER USE
C-NP REGION
1970

FIGURE 1

PRESENT STATUS

Water Quality

In evaluating water quality criteria for domestic use, two conditions of water must be considered: (a) its quality at the source of supply, be it surface water or ground water; and (b) its quality at the tap or point of use.

Water supplies serving the rural population must be of higher quality and better protected from contamination than supplies serving large communities. The small systems supplying water to outlying towns--especially the individual units--cannot afford the sophisticated equipment or the trained operators to adequately treat the water.

Table 1 shows a summary of standards or criteria that have been promulgated for natural water used as sources of domestic supply. The table presents the ranges of various standards proposed and the treatment that might be required for water quality in a particular range. It should be noted in this regard that each state department of health operates under its own code or set of regulations, which may differ with the general criteria presented in table 1. The State of Washington, for example, requires that all surface sources of domestic water be given complete treatment unless adequate protection and water quality control is provided in the tributary watershed. Comments throughout this Appendix concerning treatment needs are based on the criteria shown in table 1, however.

Table 1 - Ranges of Promulgated Standards for Raw Water Sources of Domestic Water Supply

Constituent	Excellent source of water supply, requiring disinfection only as treatment	Good source of water supply, requiring usual treatment such as filtration and disinfection	Poor source of water supply, requiring special or auxiliary treatment and disinfection
BOD (5-day) mg/l			
Monthly average:	0.75 - 1.5	1.5 - 2.5	Over 2.5
Maximum day, or sample:	1.0 - 3.0	3.0 - 4.0	Over 4.0
Coliform MPN per 100 ml			
Monthly average:	50 - 100	50 - 5,000	Over 5,000
Maximum day, or sample:	Less than 5% over 100	Less than 20% over 5,000	Less than 5% over 20,000
Dissolved Oxygen			
mg/l average:	4.0 - 7.5	4.0 - 6.5	4.0
% saturation:	75% or higher	60% or higher	---
pH			
Average:	6.0 - 8.5	5.0 - 9.0	3.8 - 10.5
Chlorides, max. mg/l	50 or less	50 - 250	Over 250
Fluorides, mg/l	Less than 1.5	1.5 - 3.0	Over 3.0
Phenolic compounds, max. mg/l	None	0.005	Over 0.005
Color, units	0 - 20	20 - 150	Over 150
Turbidity, units	0 - 10	10 - 250	Over 250

Source: (2)

The physical, chemical, and bacterial quality of drinking waters in the United States is now judged in relation to the U. S. Public Health Service (USPHS) Drinking Water Standards of 1962. Strictly speaking, the USPHS standards apply only to drinking water and water supply systems used by interstate carriers and others subject to Federal Quaratine Regulations. They have been voluntarily accepted, however, by the American Water Works Association (AWWA) and by most of the state departments of public health as criteria for all public water supplies. The extent to which they can be enforced within any state depends on the state and local laws.

The principal provisions in the 1962 standards dealing with quantative limits are condensed and summarized below:

1. Bacterial quality. When 10 ml standard portions are examined, not more than 10 percent in any month shall show the presence of the coliform group. When 100 ml standard portions are examined, not more than 60 percent in any month shall show the presence of the coliform group. When the membrane filter technique is used, the arithmetic mean coliform density shall not exceed one per 100 ml.

2. Physical characteristics. The following limiting concentrations are recommended for water in the distribution system of a water supply:

   a. Turbidity (silica scale) not to exceed 5 units.

   b. Color (standard colbalt scale) not to exceed 15 units.

   c. Threshold odor number not to exceed 3. (See Ref. (1) for explanation of units of measurement).

3. Chemical characteristics. The limits for chemical elements or compounds in water are divided into mandatory requirements for certain substances and recommended criteria for others. The mandatory and recommended criteria are presented in table 2.

4. Radioactivity. Water supplies shall be approved without further consideration of other sources of radioactivity intake of Radium-226 and Strontium-90 when the water contains these substances in amounts not exceeding 3 and 10 pico curies/liter, respectively. (A pico curie is 10^{-12} curies). When these concentrations are exceeded, a water supply shall be approved by the certifying authority if surveillance of total

intakes of radioactivity from all sources indicates that such intakes are within the limits recommended by the Federal Radiation Council for control action. In the known absence of Strontium-90 and alpha-emitters, the water supply is acceptable when the gross beta concentrations do not exceed 1,000 pico curies/liter.

Table 2 - Chemical Substances in USPHS Drinking Water Standards

Substance	Concentration in mg/l
Maximum Permissible Concentrations	
Arsenic	0.05
Barium	1.00
Cadmium	0.01
Chromium (hexavalent)	0.05
Cyanide	0.20
Fluoride	1.40 - 2.40 1/
Lead	0.05
Selenium	0.01
Silver	0.05
Recommended Limiting Concentrations	
Alkyl benzene sulfonates	0.50
Carbon chloroform extract	0.20
Chloride	250.00
Copper	1.00
Cyanide	0.01
Iron	0.30
Manganese	0.05
Nitrate, Nitrite, as N	10.00
Phenolic componds, as phenol	0.001
Sulphate	250.00
Total dissolved solids	500.00
Zinc	5.00

Source: (15)

1/ Recommended limits and maximum permissible concentrations for fluoride vary with the annual average of maximum daily air temperature. See Reference 15 for recommended lower, optimum, and upper control limits for various temperature ranges.

The ideal quality of water required for industrial use varies widely according to the many purposes for which water is used. Some of the more common and important industrial water quality requirements are listed in table 3. It is difficult to organize the quality requirements of the waters used for each of

the many industrial processes into a single set of criteria. Within any industrial plant, water may have several functions, the quality requirements for which vary markedly.

Industries are generally willing to accept for most processes water that meets drinking water standards. However, higher quality water is needed for certain industrial uses such as food and beverage preparation and high pressure boilers. For instance, in the Columbia-North Pacific Region, nearly all high temperature and high pressure boilers require scale and corrosion inhibitors in their makeup water.

One characteristic is of primary importance to all industries; namely, the concentrations of the various constituents of the water should remain relatively constant. Short-time variations in concentrations of substances in the process water require continued attention and added expense. Generally, lower quality water that is consistent in quality is easier to treat than water of higher quality which varies.

The California Water Pollution Control Board (5) and the National Technical Advisory Committee to the Secretary of the Interior (6) have developed sets of approximate standards for most industrial water uses which should be referred to for more detailed information. Data on existing quality in the subregions were obtained from various Federal, State, and private sources.

Treatment

The treatment given water prior to distribution by municipal water facilities is determined by the requirements of the various state boards of health and the desires of the consumer. In some instances, treatment is provided to assure production of water of a satisfactory quality to meet the USPHS requirements for an interstate carrier watering point, as well as to satisfy state requirements. In the Columbia-North Pacific Region regulations of some state boards of health require that any surface water used for a domestic supply must be given complete treatment or the watershed must be rigidly controlled.

Treatment for suspended sediment reduction is accomplished in several different manners, either as a single measure or in combination. Suspended sediment at the source is controlled to some extent by source impoundments and by utilizing an infiltration gallery as the intake. Further reduction is accomplished by chemical and mechanical aids to flocculation. Filtration is the final and ultimate means of reducing the suspended sediment concentrations.

Table 3 - Summary of Specific Quality Characteristics of Surface Waters that Have Been Used as Sources for Industrial Water Supplies

Characteristic	Boiler makeup water: Industrial 0 to 1,500 psig	Boiler makeup water: Utility 700 to 5,000 psig	Cooling water: Fresh: Once through	Cooling water: Fresh: Makeup recycle	Cooling water: Brackish 1/: Once through	Cooling water: Brackish 1/: Makeup recycle	Textile industry, SIC-22	Lumber industry, SIC-24	Pulp and paper industry, SIC-26	Chemical industry, SIC-28	Petroleum industry, SIC-29	Prim. metals industry, SIC-33	*Food and* kindred products, SIC-20; Leather industry, SIC-31
Silica (SiO_2) ------	150	150	50	150	25	25	------	------	50	-------	50	------	For the above 2 categories the quality of raw surface supply should be that prescribed by the NTA Subcommittee on Water Quality Requirements for Public Water Supplies. *(See Table 2)*
Aluminum (Al) ------	3	3	3	3	-----	------	------	------	------	-------	------	------	
Iron (Fe) ---------	80	80	14	80	1.0	1.0	0.3	------	2.6	5	15	------	
Manganese (Mn) -----	10	10	2.5	10	0.02	0.02	1.0	------	------	2	------	------	
Copper (Cu) --------	------	------	------	------	------	------	0.5	------	------	------	------	------	
Calcium (Ca) -------	------	------	500	500	1,200	1,200	------	------	------	200	220	------	
Magnesium (Mg) -----	------	------	------	------	------	------	------	------	------	100	85	------	
Sodium and potassium (Na + K).	------	------	------	------	------	------	------	------	------	------	230	------	
Ammonia (NH_3) ------	------	------	------	------	------	------	------	------	------	------	------	------	
Bicarbonate (HCO_3) -	600	600	600	600	180	180	------	------	------	600	480	------	
Sulfate (SO_4) ------	1,400	1,400	680	680	2,700	2,700	------	------	------	850	570	------	
Chloride (Cl) ------	19,000	19,000	600	500	22,000	22,000	------	------	200 2/	500	1,600	500	
Fluoride (F) -------	------	------	------	------	------	------	------	------	------	------	1.2	------	
Nitrate (NO_3) ------	------	------	30	30	------	------	------	------	------	------	8	------	
Phosphate (PO_4) ----	------	50	4	4	5	5	------	------	------	------	------	------	
Dissolved solids ---	35,000	35,000	1,000	1,000	35,000	35,000	150	------	1,080	2,500	3,500	1,500	
Suspended solids ---	15,000	15,000	5,000	15,000	250	250	1,000	3/	------	10,000	5,000	3,000	
Hardness ($CaCO_3$) ---	5,000	5,000	850	850	7,000	7,000	120	------	475	1,000	900	1,000	
Alkalinity ($CaCO_3$) -	500	500	500	500	150	150	------	------	------	500	------	200	
Acidity ($CaCO_3$) ----	1,000	1,000	0	200	0	0	------	------	------	------	------	75	
pH units ----------	-----	------	5.0-8.9	3.5-9.1	5.0-8.4	5.0-8.4	6.0-8.0	5-9	4.6-9.4	5.5-9.0	6.0-9.0	3-9	
Color units --------	1,200	1,200	------	1,200	------	------	------	------	360	500	25	------	
Organics:													
Methylene blue active substances.	2 4/	10	1.3	1.3	------	1.3	------	------	------	------	------	------	
Carbon tetrachloride	100	100	5/	100	5/	100	------	------	------	------	------	30	
Chemical oxygen demand (O_2).	100	500	-----	100	------	200	------	------	------	------	------	------	
Hydrogen sulfide (H_2S).	------	------	------	------	4	4	------	-------	------	------	------	------	
Temperature, F------	120	120	100	120	100	120	------	------	95 6/	------	------	100	

1/ Water containing in excess of 1,000 mg/l dissolved solids.
2/ May be $\leq$1,000 for mechanical pulping operations.
3/ No large particles $\leq$3mm diameter.
4/ 1 mg/l for pressures up to 700 psig.
5/ No floating oil.
6/ Applies to bleached chemical pulp and paper only.

NOTE--Application of the above values should be based on Part 23, ASTM book of standards (1) or APHA Standard methods for the examination of water and waste water (5).

Note: Unless otherwise indicated, units are mg/l and values are maximums. No one water will have all the maximum values shown.

Measures for control of obnoxious tastes and odors from biological growths also start at the source. Copper sulfate and activated carbon are sometimes added at source impoundments. Further control measures include superchlorination, dechlorination, use of activated carbon, and filtration at the treatment plant.

Control of bacterial contamination, aside from anti-pollution programs, is accomplished by flocculation, filtration, and disinfection. Chlorine has been used as the disinfectant at most of the region's water treatment plants. While bacterial contamination is not immediately identifiable, a chlorine residual may be determined in a matter of minutes. An adequate residual of available chlorine assures a complete kill of bacteria within a short period of time.

A summary of treatment practices is presented in table 4. Mineral removal and specialized treatment are not listed. Many communities relying on surface or mixed sources only provide disinfection before distribution. A number of municipalities withdrawing from major streams practice four-stage treatment (sedimentation, flocculation, filtration, and disinfection). Ground-water supplies must also be treated in some instances. Wells in shallow aquifers are subject to bacterial contamination, and chlorination is therefore required. Mineral removal is also practiced at several communities using hard water from ground sources.

Table 4 - Summary of Municipal Water Sources and Treatment Practices, Columbia-North Pacific Region

Source	Municipal Facilities (number)	Population Served (thousands)	Total Population (percent)
Surface			
No treatment	19	10.6	0.2
Disinfection	156	2,189.5	48.3
Complete (See Glossary)	45	337.5	7.4
	220	2,537.6	55.9
Ground			
No treatment	371	485.8	10.7
Disinfection	183	961.1	21.2
Complete	2	5.4	0.1
	556	1,452.3	32.0
Mixed			
No treatment	10	13.6	0.3
Disinfection	38	466.5	10.2
Complete	5	71.4	1.6
	53	551.5	12.1
Total	829	4,541.4	100.0

Municipal

The need for municipal water supply is created by a number of special uses, including domestic, commercial, public, fire, and industrial. The size of the community, its location, number and diversity of commercial business establishments, community habits, availability, quality and cost of water, existance of sewers, public policy with respect to civic duties, and size and type of industries within any city are characteristics particular to the city under consideration. As a consequence, the municipal water need computed on a per capita basis can be expected to vary among cities. Municipal water needs are taken as the total needs of the community less the water needs of major industrial users.

For purposes of developing overall data on municipal water requirements in the Columbia-North Pacific Region, it has been found that the climatic-geographic area and population are the most important variables if major industrial users are subtracted. (17) To facilitate this analysis, the region was arbitrarily divided into three climatic-geographic designations, with the following general characteristics:

1. Continental, dry summer, winter rain, 20-50 inches/year precipitation.

2. Continental, arid summer, winter snow, less than 20 inches/year precipitation.

3. Coastal area, dry summer, winter rain, 30-100 inches/ year precipitation.

A fourth designation was the region as a whole. Data for all sources in each of these categories were studied with respect to population range, average use of water, maximum monthly use, maximum daily use, and unaccounted-for water.

Table 5 shows the summary of mean values of 1960 per capita water use and the 1960 per capita design needs for each of the above described designations, and for population ranges of less than 10,000; 10,000 to 20,000; greater than 20,000, and a combination of all sizes. Water use values reflect metered consumption values; design needs represent water needed at urban limits. It was determined from a few well-operated municipalities that unaccounted-for water is in the order of 20 percent of the metered consumption. Therefore, 20 percent was added to the 1960 use value to obtain the 1960 design need value which was subsequently used as a base for projections. Below the main tabulation are shown some typical per capita use data indicated in other studies. The values presented in table 5 represent only the average requirements for the various climatic designations

Table 5 - Summary of Municipal Water-Use Study
Columbia-North Pacific Region

Climatic Designation	Population Range	1960 Use	1960 Design Need
		GPCD	
1	< 10,000	143	170
	10 - 20,000	177	210
	> 20,000	173	210
	All sizes	150	180
2	< 10,000	213	255
	10 - 20,000	196	235
	> 20,000	209	250
	All sizes	210	250
3	< 10,000	130	155
	10 - 20,000	119	145
	> 20,000	140	170
	All sizes	133	160
4	< 10,000	186	235
	10 - 20,000	174	210
	> 20,000	173	210
	All sizes	181	215

All sizes and climatic designations		
PNW AWWA	1962	166
National AWWA	1964	166
Porges	1957	183
Kollar & Youngwirth	1963	191
Westgarth (Oregon)	1952	193
Britton (Willamette)	1964	151

A complete list of references from which the above values were obtained is contained in Reference 17.

Climatic Designation

1. Dry summer, winter rain. 20-50 in./yr. precipitation.
2. Arid summer, winter snow. 20 in./yr. precipitation.
3. Coastal area, dry summer, winter rain, 30-100 in./yr. precipitation.
4. Total Columbia-North Pacific Region.

and are used in planning for total water needs. The average rate during a maximum use month is considered to be approximately twice the values shown; the average rate during a maximum day is considered approximately 2.7 times the values shown. (17) Water needs throughout this Appendix are presented in terms of MGD. See the Glossary for the conversion to acre-feet.

The Public Health Service Inventory of Municipal Water Facilities was the principal source of data concerning population served by municipal facilities, source of water supply, and type of water treatment practices. These data were revised when the respective states indicated that there had been significant changes. Data from some communities with less than 250 people were included in calculation of per capita use for the population range designation of under 10,000, even though for the remainder of this study communities with under 250 people are classed as rural-domestic.

Monthly variation of need was based on table 6 for the four climatic designations, unless more specific information was available for a particular community or service area. These data show the month of July as the maximum-use month. June, July, August, and September are all high use months.

Table 6 - Percent Variation in Municipal Water Needs by Month, Columbia-North Pacific Region

Month	Climatic Designation 1	2	3	4
January	73	67	77	71
February	72	70	89	73
March	68	71	77	70
April	75	86	91	80
May	75	90	86	81
June	120	143	111	101
July	185	186	123	179
August	175	145	138	161
September	120	121	113	119
October	88	81	97	84
November	77	72	78	74
December	76	66	89	76

There are 829 municipal water supply facilities in the Columbia-North Pacific Region furnishing water to over 4.7 million persons (about three-fourths of the regional population). The total water use for municipal purposes amounts to 778 million gallons per day (mgd). Approximately 70 percent of the water demand is concentrated in the 34 service areas.

Figure 1 summarizes the relationship of municipal to industrail water use by subregion. Heavily populated Subregion 11 has a municipal use of 218 mgd, or 28 percent of the regional total. Subregions 1 and 9 account for 15 and 20 percent, respectively, of the municipal needs. With the exception of Subregion 12, which has very minor water needs, the remaining subregions utilize between 20 and 45 mgd for municipal purposes.

Subregions 9, 10, and 11 primarily use surface waters for municipal purposes. In addition, a number of communities in Subregions 1, 2, 7, and 8 utilize surface sources, but must depend upon ground-water supplies. In the remaining subregions, groundwater sources are used almost exclusively for municipal supplies. Over two-thirds of the municipal facilities in the region withdraw water from underground sources, but furnish less than one-third of the total municipal requirements. This condition is the result of the fact that most of the major service areas, particularly those west of the Cascade Range, obtain water from surface sources. These major service areas include Seattle, Portland, Tacoma, Salem, Eugene-Springfield, and Everett.

Industrial

Industrial water requirements are complicated by many factors and hence display great variability. Every product requiring water in its manufacture utilizes differing quantities and qualities of water; and even in the manufacture of identical products the amounts of water used vary, depending on the process involved.

Actual industrial water usage has been presented when data are available. However, in many areas such information is lacking. In these areas, industrial water use has been computed in general terms on the basis of daily use per employee or per unit of production. The Bureau of Census (12) and (13) has collected water-use figures for various regions in the United States for the larger industrial categories. The data presented in the Census reports were statistically analyzed in a recent study (4) and the figures derived were utilized for calculating industrial water use in the region.

The total industrial water use amounts to about 1,638 mgd. The amount excluded that withdrawn for cooling in thermal power generation. The pulp and paper industry is the largest water-use category, requiring 952 mgd, or nearly 60 percent of the total industrial requirement. The primary metals, food processing, lumber and wood products, and chemical products industries are also major water users. These industries use 14, 8, 12, and 6 percent respectively, of the total industrial need.

Over 70 percent of the industrial water use is concentrated in the 34 service areas.

Figure 1 summarizes the relationship of municipal to industrail and rural-domestic water use by subregions. The four subregions west of the Cascades account for over three-quarters of the industrial water usage. Of these, Subregions 8 and 11 have the largest needs, requiring about 354 and 432 million gallons of water per day, respectively. In Subregions 9 and 10, industries withdraw about 202 and 221 mgd, respectively. In these four subregions, the pulp and paper and the lumber and wood products industries have the greatest needs, although large quantities of water are required by the primary metals and food-processing industries. East of the Cascade Range, Subregion 1 has the largest industrial water usage, with the primary metals industry, including mining operations, as the principal water user.

The primary metals industry is also a significant water user in Subregions 7 and 8. Food processing requires large quantities of water in the other eastern subregions, with the exception of Subregion 6. In Subregions 1, 3, and 7, lumber and wood products industries use large volumes of water. The only other important water uses are by chemical products plants in Subregion 4 and a pulp and paper mill in Subregion 6.

In general, most industries have developed adequate independent water supplies. However, a number of food-processing firms obtain water from municipal facilities. In the western subregions, water supplies are most often withdrawn from surface sources. The largest water-using industries in the eastern subregions generally depend upon surface sources, but most smaller water-using industries utilize underground sources.

Rural-Domestic

The rural-domestic category includes water uses for domestic needs, stock watering, and small-scale irrigation.

The rural population is considered to be that population not connected to municipal or centralized water distribution systems serving a population of greater than 250 people. For purposes of this study, the per capita domestic water needs are assumed to be one-half of the average municipal per capita requirement for each climatic designation, as determined in the municipal water supply section, and includes small scale irrigation needs.

To determine the stock-watering need, daily water-use figures of 15 gallons per head for cattle, 1 gallon per head for sheep, and 5 gallons per head for hogs are assumed to be representative for the region. The animal populations were derived from the 1964 Census of Agriculture for each state in the study area.

Table 7 summarizes by subregion the total rural-domestic water need, the domestic water need, and the livestock watering requirement in the region as of 1965. Also included are the population and the percent of population served by rural systems.

Table 7 - Summary of Rural-Domestic Population and Water Needs as of 1965, Columbia-North Pacific Region

Subregion	Population Served by Rural Systems	Percent Subregion Population Served by Rural Systems	Domestic Water Use (MGD)	Livestock Watering Use (MGD)	Total Rural-Domestic Needs (MGD)
1	126,670	21.3	16.0	6.8	22.8
2	79,620	32.0	10.0	6.0	16.0
3	91,610	49.7	11.5	4.4	15.9
4	121,200	40.2	15.3	12.5	27.8
5	102,850	38.3	12.8	12.0	24.8
6	48,610	29.8	6.2	6.3	12.5
7	68,920	32.7	8.4	7.9	16.3
8	75,100	34.1	6.7	2.2	8.9
9	202,400	15.1	11.8	4.5	16.3
10	142,900	33.5	11.4	0	11.4
11	149,150	7.6	8.5	0	8.5
12	7,400	55.6	0.7	2.9	3.6
Total	1,216,430	20.5	119.3	65.5	184.8.

Approximately 185 million gallons are required daily to satisfy the rural-domestic need. The rural population uses about 119 mgd, and livestock watering has an additional requirement of 66 mgd.

The summary table shows that less than one-quarter of the regional population is served by rural water systems. However, this figure is not representative of most of the study area. Heavily populated Subregion 11, of which only about 8 percent of the population is rural, tends to overshadow the actual situation. In 8 of the 12 subregions, over 30 percent of the population is served by rural systems.

The largest livestock watering use occurs east of the Cascade Range. Subregions 1, 2, 4, 5, and 7 have particularly high water requirements for the large animal population.

FUTURE NEEDS AND MEANS TO SATISFY NEEDS

As part of the framework water resources planning effort for the Pacific Northwest, trends in municipal, industrial, and rural-domestic water use were analyzed, and future water needs were projected. Gross needs were projected for each subregion, subbasin, and service area. Many of these projections suggest areas of future water shortages and point up possible changes in water sources or treatment practices, or the need for increased efficiency in existing water use.

No attempt was made to forecast water needs of individual industries or communities but, rather, these forecasts were made for subbasins and service areas on the basis of their size and composition. The accuracy of projections based on distribution of quantities projected for large areas into their components diminishes as the component areas become smaller and more specific. Projections of requirements for such units should be made by individual communities and industries concerned, in conjunction with competent consulting engineers. The area-wide projections given here will provide a guide and checkpoint for such forecasts.

The estimated 1965 municipal, major industrial, and rural-domestic water requirement in the Columbia-North Pacific Region of 2,601 mgd is projected to increase 61 percent to 4,186 mgd by 1980, 137 percent to 6,153 mgd by 2000, and 232 percent to 8,625 mgd by 2020.

Municipal

Basis for Water Supply Projections

Significant changes will occur in our mode of life during the next 50 years. The technological advances of society will result in a new sociology based upon science and emphasizing urban living. As a consequence, the magnitude and distribution of the future municipal water requirement can be expected to change significantly. The most important variations will be related to the population growth, increased urbanization, and increased per capita water consumption.

The regional and subregional population data and projections used in the determination of water supply needs are shown in table 8 and, with the exception of Subregions 9 and 11, were derived from data prepared by the Office of Business Economics (OBE). The OBE data were developed, in most cases, along county lines roughly corresponding to the subregion boundaries. In some areas, however, the difference between the boundaries used by the OBE and the subregional hydrologic boundries involves a significant portion of the population. In these areas, for water supply purposes, the OBE data were adjusted to conform with the subregional hydrologic framework. The OBE data includes the cities of Richland and Kennewick, Washington in Subregion 3; for purposes of the water supply study these two cities were included in Subregion 2, along with Pasco, Washington, to form the Tri-Cities Service Area. Also the OBE data include in Subregion 8, that portion of the Chehalis River Basin contained in Lewis County. To conform to the hydrologic framework, that portion of the Chehalis was included in Subregion 10 for the water supply study. The population projections for Subregions 9 and 11 were taken from more detailed Type 2 studies which were prepared for those two subregions. For comparison purposes, the population data prepared by the OBE are shown at the bottom of table 8 for those subregions where the OBE data are different from the data used in the water supply study. The OBE data may also be found in Appendix VI (Economic Base and Projections) of this framework study. The subregional populations are further divided into subbasins and major service areas, and these projections are also presented in respective subregional sections.

Major growth in population is expected to occur in concentrated areas and cities with vast suburban fringes. As a result, municipal water systems will greatly expand in size and scope of operation. As people move from city core areas into suburban communities, there will be a need for extension of municipal services into these areas. Municipal water systems will develop into central water purveyors selling bulk water to secondary suppliers in outlying communities as as supplying adequate service to those within city limits. The projected population to be served by municipal systems is shown in table 8. The rate of increase in urbanization has been largely based on historical trends.

The forecasts of municipal per capita water consumption in the region are based on a statistical analysis of municipal supplies of the Pacific Northwest (17) carried out within the Columbia River Basin Comprehensive Project. The results of this study are presented in table 9 for designated population ranges and climatic areas as previously discussed in the "Present Status" section. The growth in per capita demand was based on observed chronological water-use increases in selected cities of the

Table 8 - Projected Population, Columbia-North Pacific Region

	1965 (Base Year)	1980	2000	2020
Subregion 1	595,100	699,100	897,100	1,140,400
Municipal	468,400	579,100	781,100	1,025,400
Rural	126,700	120,000	116,000	115,000
Subregion 2	250,200	322,500	430,800	548,000
Municipal	170,600	252,100	355,700	467,500
Rural	79,600	70,400	75,100	80,500
Subregion 3	184,500	211,200	258,400	327,000
Municipal	92,900	130,100	190,400	273,000
Rural	91,600	81,100	68,000	54,000
Subregion 4	302,000	350,900	450,500	576,500
Municipal	180,800	256,000	369,900	505,400
Rural	121,200	94,900	80,600	71,100
Subregion 5	268,500	328,700	430,400	553,500
Municipal	165,700	231,700	341,900	473,500
Rural	102,800	97,000	88,500	80,000
Subregion 6	163,300	193,500	234,600	274,300
Municipal	114,700	142,300	185,300	231,600
Rural	48,600	51,200	49,300	42,700
Subregion 7	210,300	251,400	321,900	404,400
Municipal	141,400	183,200	251,900	331,600
Rural	68,900	68,200	70,000	72,800
Subregion 8	220,300	254,900	324,400	414,300
Municipal	145,200	208,900	282,600	378,500
Rural	75,100	46,000	41,800	35,800
Subregion 9	1,338,900	1,767,500	2,422,000	3,591,000
Municipal	1,136,500	1,535,600	2,164,700	3,291,200
Rural	202,400	231,900	257,300	299,800
Subregion 10	425,800	488,500	600,400	735,900
Municipal	282,900	351,700	475,300	624,100
Rural	142,900	136,800	125,100	111,800
Subregion 11	1,972,700	2,759,800	4,384,000	6,950,800
Municipal	1,823,500	2,579,700	4,177,300	6,709,000
Rural	149,200	180,100	206,700	241,800
Subregion 12	13,300	16,300	18,700	21,300
Municipal	5,900	9,000	12,400	16,300
Rural	7,400	7,300	6,300	5,000
Total Region	5,944,900	7,644,300	10,773,200	15,537,400
Municipal	4,728,500	6,459,400	9,588,500	14,327,100
Rural	1,216,400	1,184,900	1,184,700	1,210,300

Preliminary Office of Business Economics Projections
(for comparison purposes only)

Subregion 2	198,600	253,000	334,000	431,300
Subregion 3	236,700	280,700	355,200,	443,700
Subregion 8	240,100	277,900	349,400	441,300
Subregion 9	1,338,900	1,727,300	2,397,600	3,237,200
Subregion 10	405,500	465,500	575,400	708,900
Subregion 11	1,904,100	2,449,700	3,345,300	4,448,100
Total Region	5,876,300	7,294,000	9,710,100	12,680,400

Table 9 - Municipal Per Capita Water-Use Projections
Columbia-North Pacific Region

Climatic Designation	Population Range	Design Year Needs 1960	1980	2000	2020
			(GPCD)		
1	< 10,000	170	195	215	230
	10 - 20,000	210	235	255	270
Subregions 8 & 9	> 20,000	210	235	255	270
	All sizes	180	205	225	240
2	< 10,000	255	280	300	315
	10 - 20,000	235	260	280	295
All other	> 20,000	250	275	295	310
subregions	All sizes	250	275	295	310
3	< 10,000	155	180	200	215
	10 - 20,000	145	170	190	205
Subregions 10 & 11	> 20,000	170	195	215	230
	All sizes	160	185	205	220
4	< 10,000	235	260	280	295
	10 - 20,000	210	235	255	270
	> 20,000	210	235	255	270
	All sizes	215	240	260	275

Climatic Designation

1. Dry summer, winter rain. 20-50 in./yr. precipitation.
2. Arid summer, winter snow. 20 in./yr. precipitation.
3. Coastal area.
4. Total Columbia-North Pacific Region.

Design Data

Per capita use increase = 1.2 gpcd per year (1960-1980).
(Assumed for projections) = 1.0 gpcd per year (1980-2000).
= 0.8 gpcd per year (2000-2020).

Source: (17)

Northwest during past years. Increases of 1.2 gpcd per year for the period 1960 to 1980, 1.0 gpcd per year for 1980 to 2000, and 0.8 gpcd per year from 2000 to 2020 were used. The decreasing rate of increase in demand reflects the expected increase in the value of water through the planning period.

Projections of Water Supply Requirements

The per capita demand figures were applied directly to distributed municipal population projections presented in table 8 to provide municipal water-use projections for the subregions, subbasins, and major service areas. The projected regional and subregional water requirements are presented in table 10. Projections based on OBE population estimates for Subregions 9 and 11 are also shown. Since base conditions reflect inventory data for the year 1965, data presented for all later years should be considered as projections. Thus, data presented throughout this Appendix for the years 1970 through 2020 are shown in tables as projections.

The municipal water requirements reflect average daily needs; however, water requirements can fluctuate widely, depending on the type of use, season of the year, weather, and time of day. Earlier in this Appendix, monthly patterns of present water use were presented. It is expected that the monthly demand hydrograph will remain relatively unchanged throughout the projection period. Table 11 summarizes the expected percent of monthly municipal water demand variation by subregion. The ratios of maximum monthly demand and maximum daily demand to the average demand will continue to be about 2.0 and 2.7 respectively. (17)

Problems

While the steadily mounting need for water will not strain the abundant surface- and ground-water resources of the region, localized supply difficulties are certain to emerge. Although there is a sufficient total supply of water to meet total requirements well into the next century, the capacity of existing sources to satisfy future needs at the necessary times and places is highly questionable.

Table 10 - Projected Municipal Water Use, Columbia-North Pacific Region

Subregion	1965 (Base Year)	1970	1980 (MGD)	2000	2020
1	116.7	131.1	159.9	228.3	319.0
2	42.4	49.0	62.2	98.6	145.2
3	23.7	28.7	38.7	59.1	81.9
4	45.6	53.9	70.6	109.1	156.4
5	41.3	48.7	63.5	100.4	145.7
6	28.1	31.7	39.0	55.4	72.0
7	38.5	42.9	51.0	75.1	96.6
8	24.7	33.3	47.1	70.4	100.4
9	152.9	211.8	329.6	512.4	832.7
10	44.4	51.2	65.2	98.7	140.5
11	218.1	302.7	477.0	736.4	1,231.5
12	1.5	1.8	2.5	3.7	5.1
Total Region	777.9	986.8	1,401.3	2,147.6	3,327.0
Projected Municipal Water Use Based on OBE Population Projections					
9			290.4	480.1	738.9
11			428.3	661.9	957.0
Total Region			1,318.4	2,040.8	2,958.7

NOTE: 1968 Preliminary OBE Projections shown for comparison purposes.

Table 11 - Monthly Variation in Municipal Water Needs
Columbia-North Pacific Region

Month	Subregions 8 and 9	Subregions 10 and 11	All Others	Region in Total
	Percent of average			
January	73	77	67	71
February	72	89	70	73
March	68	77	71	70
April	75	91	86	80
May	75	86	90	81
June	120	111	143	101
July	185	123	186	179
August	175	138	145	161
September	120	113	121	119
October	88	97	81	84
November	77	78	72	74
December	76	89	66	76

Source: (17)

The most significant present and potential water supply problems are in localized areas of the Columbia Plateau, Snake Plain, and Oregon Closed Basin, where ground-water sources are almost exclusively utilized for municipal supplies. Common problems encountered in these areas are excessive depths of the water table, aquifers of low yield, and quality problems, including excessive mineralization, objectionable trace constituents, high temperatures, and gasses.

In areas where ground-water supplies are not available, the surface-water supplies must be developed. Problems with low yielding aquifers can be alleviated by expanding the well fields and reprogramming the pumping schedules. Lowering the pumps to increase the drawdown will move more water to the well and increase the yield for a time, but a more permanent remedy is to enlarge the well field by installing additional wells and reducing the pumpage per well. Other solutions which should always be explored are managing aquifers for sustained yields and reducing per capita consumption. Where the quality of ground water is not satisfactory, treating the water to the desired quality is usually the only solution. On occasion, aquifers yielding higher quality water have been found at greater depths and in new locations.

Desalting of brackish or sea water is another possible source of future water supplies. At present, this alternative is generally economically feasible only where the nearest potable supply is a considerable distance away. For this reason desalting was not considered a viable alternative in most areas of the region. However, as technology in the field advances, decreasing costs of the process may make it more attractive and may require that it be given more consideration as a means of providing future water supply needs.

Many areas of the region utilizing surface-water sources experience short-term deficiencies due to seasonal streamflow shortages and transmission and treatment limitations. Streamflow shortages may be overcome with storage. A good portion of this need can be met by inclusion of storage in Federal multipurpose reservoirs. Conjunctive use of ground water is another possible solution to the short-term deficiency. Smaller communities are normally the ones with the most serious water supply problems, and these are primarily financial.

A major problem facing many municipalities in the future will be the selection of new or additional sources of water supply. In the past, civic pride and aesthetics have often been major factors in source selection and have at times displaced economics as the deciding factor in source development. For this reason, future sources cannot be readily identified just because

they happen to be close and the least expensive alternates. Another problem in selecting a new source of water in some areas is that of determining how much water is physically and legally available for additional appropriation. A tabulation of water rights may show the legal demand on a particular supply but the actual use may be quite different, depending on the extent to which holders of water rights exercise those rights and the extent to which illegal appropriations are occurring.

It can be anticipated in the future that, as municipal systems are expanded and replaced, communities will have to shift to complete treatment of their raw surface-water supplies. Maintenance of controlled, limited-access watersheds, such as those employed by Portland, Seattle, Tacoma, and Everett, will become increasingly difficult due to greater pressure on these areas due to multiple-use development.

Another problem which must be considered in planning for future water supplies is that of the inefficiencies inherent in situations where several water service districts are organized to serve various single interests. In many areas consolidation of these districts and better management could result in considerable savings in water use and could permit local water needs to be satisfied in the future without large expenditures for new water resource developments. Thus a portion of any water supply planning effort should be devoted to consolidating and upgrading existing service districts to get the maximum returns on past and proposed investments.

Industrial

Basis for Water Supply Projections

Future water use in industry will be greatly affected by inplant water management improvements and technological changes. Although some new processes will lead to higher water use per unit of product, most changes will reduce water use per unit in response to pressure for waste volume reduction from pollution control agencies and increasing cost of water. No rational method for accurately estimating the timing or impact of such changes is available. Consequently, future water use per unit of production was assumed to be equal to the present water use per unit of production except for the primary metals and chemicals categories where employment was used as the basis for projections.

Industrial water requirements were estimated for pulp and paper, lumber and wood products, primary metals, food products, chemicals, and other manufacturing categories by subregion, subbasin, and service area where applicable. In all categories, future demand projections are the product of present water use and a growth index. Growth indices for food products were obtained from table 51 in Appendix VI. Indices for pulp and paper and lumber and wood products were derived from data on present and projected wood consumption contained in tables 17 and 20 of Appendix VI. The indices for the primary metals and chemicals industries were derived from present and projected employment compiled in Reference 16. Table 12 shows the overall growth indices for the region. These indices were used for projections of industrial water use in all subregions, except in Subregions 9 and 11, where projections in the Type 2 study were used.

Table 12 - Industrial Growth Indices
Columbia-North Pacific Region

Subregion	Food Products			Pulp and Paper			Lumber and Wood Products			Primary Metals			Chemicals		
	1980	2000	2020	1980	2000	2020	1980	2000	2020	1980	2000	2020	1980	2000	2020
1	1.29	1.79	2.46	1.95	3.29	3.59	0.99	0.91	0.87	1.29	1.44	1.74	1.37	1.93	2.66
2	2.17	3.44	5.22	2.67	4.33	6.67	1.36	1.55	1.63	1.37	1.67	1.97	1.27	1.59	1.91
3	1.62	2.36	3.39	--	--	--	1.39	1.69	1.85	--	--	--	1.24	1.35	1.85
4	1.70	2.46	3.13	--	1.00	2.92	1.14	1.14	1.00	--	--	--	1.50	2.20	3.02
5	1.63	2.36	3.05	1.00	2.62	5.35	1.12	1.22	1.13	--	--	--	--	--	--
6	1.84	2.54	2.79	1.21	1.38	1.56	1.17	1.28	1.21	--	--	--	--	--	--
7	1.66	2.30	3.18	1.34	2.12	2.31	1.09	1.16	1.23	2.93	3.29	3.67	--	--	--
8	1.54	2.15	2.97	1.48	2.13	2.34	0.92	0.96	0.88	1.94	2.21	2.47	1.53	2.31	3.23
9	1.48	2.05	2.86	2.14	2.71	2.81	0.69	0.69	0.72	1.93	2.17	2.42	1.53	2.31	3.23
10	1.63	2.25	3.12	1.90	2.49	2.64	0.82	0.77	0.73	2.73	4.08	5.06	1.53	2.31	3.23
11	1.50	2.09	2.88	1.42	2.07	2.27	1.16	1.13	0.95	1.27	1.31	1.34	1.42	1.98	2.62
12	1.61	3.21	4.40	--	--	--	1.04	1.04	1.07	--	--	--	--	--	--
Total Region	1.57	2.22	3.02	1.62	2.33	2.59	0.93	0.92	0.89	1.55	1.76	1.97	1.37	1.85	2.41

Projections of Water Supply Requirements

The projected industrial water requirements are summarized in table 13 for the years 1970, 1980, 2000, and 2020 for each subregion. As mentioned in the municipal water supply discussion, these requirements represent average daily needs. This is probably adequate for the pulp and paper, lumber and wood products, chemical products, and primary metals industries since their water use is rather uniform throughout the year; but water use by the

food products industry varies widely on a monthly basis--up to 600 percent of the average monthly need for food processing.

Table 13 - Projected Industrial Water Use, Columbia-North Pacific Region

Subregion	1965 (Base Year)	1970	1980	2000	2020
			(MGD)		
1	139.6	153.3	181.0	214.4	247.5
2	46.8	56.8	78.4	107.7	144.5
3	21.0	26.4	32.2	44.1	58.6
4	72.3	85.7	112.7	172.5	248.6
5	29.6	34.2	54.0	88.9	129.3
6	55.0	59.1	67.4	77.1	85.4
7	63.8	74.8	96.7	113.6	139.2
8	354.4	409.1	518.4	739.2	849.5
9	201.7	221.9	262.1	382.7	571.2
10	221.0	267.6	360.7	463.8	504.5
11	431.9	543.3	765.9	1,285.5	1,930.6
12	1.4	1.5	1.6	1.6	1.7
Total	1,638.5	1,933.7	2,531.1	3,691.1	4,910.6

Problems

Industrial water supply problems in the Columbia-North Pacific Region are generally localized in nature. Water shortage problems that have curtailed industrial development occur in certain areas in the Columbia Plateau, Snake Plain, and Oregon Closed Basin, as mentioned in the section on municipal problems, as well as in many areas throughout the region due to short-term seasonal streamflow deficiencies. Water quality problems that necessitate special treatment practices occur in many areas. Surface water used by the food and beverage industries requires disinfection in a number of locations; however, this is standard practice throughout the United States. Industries requiring water with very low concentrations of fluvial sediment or turbidity would have to treat most of the surface waters in the Pacific Northwest at some time during the year. Most ground and surface waters in the region to be used for high temperature and high pressure boilers require silica and sometimes other mineral removal or scale and corrosion inhibitors in their makeup.

Rural-Domestic

Basis for Water Supply Projections

Future rural-domestic water supply requirements are dependent upon the same factors that affect the municipal needs; namely,

increased population, increased urbanization, and increased per capita water use. In addition, since the rural-domestic use also includes livestock-watering requirements, the number and distribution of the large animal population also influence the requirements.

The rural population is the difference between the total population of an area and that population in the area served by municipal water supply systems. The rural population is presented in table 8 for each subregion. In most cases, the projected rural population in service areas is small, since it is assumed that such areas will be completely served by municipal systems in the near future. (See projections in each subregional section of this Appendix.)

The per capita water consumption of the rural portion of the population is presently estimated to be about one-half of that required by municipal systems in the surrounding area. However, per capita water use by this component of society is expected to increase due to a more modern form of rural life. Lawn sprinkling and increased use of modern appliances in rural areas will account for a large portion of this increase. As a result, it has been assumed, for projection purposes, that the ratio of rural per capita demand to the municipal per capita demand in the surrounding areas will be 0.6 in 1980, 0.7 in 2000, and 0.8 in 2020.

The projected livestock population in the region is based on information presented in Appendix VI. It has been assumed that the water use per head of livestock will remain essentially unchanged throughout the projection period.

Projections of Water Supply Requirements

The domestic water requirement was forecast on the same basis as the municipal requirement; that is, by multiplying the population and the per capita water consumption for the respective areas. Table 14 presents the average daily domestic water need by subregion. The monthly variation of this need can be expected to be nearly the same as that for surrounding municipal systems.

The livestock requirement is also obtained by directly applying the livestock population to the average water need per head and is shown in table 14.

The total rural-domestic water need (the sum of the domestic and livestock requirements) is also presented in table 14.

Table 14 - Projected Rural-Domestic Water Use, Columbia-North Pacific Region

	1965 (Base Year)	1970	1980	2000	2020
			(MGD)		
Subregion 1	22.8	24.9	28.9	35.8	44.6
Domestic	16.0	17.0	19.8	23.7	28.7
Livestock	6.8	7.9	9.1	12.1	15.9
Subregion 2	16.0	18.7	21.9	29.0	38.0
Domestic	10.0	10.7	11.6	15.4	20.1
Livestock	6.0	8.0	10.3	13.6	17.9
Subregion 3	15.9	17.9	21.2	24.4	27.0
Domestic	11.5	11.6	13.4	13.9	13.4
Livestock	4.4	6.3	7.8	10.5	13.6
Subregion 4	27.8	30.4	35.6	44.0	53.4
Domestic	15.3	15.4	15.6	16.7	17.6
Livestock	12.5	15.0	20.0	27.3	35.8
Subregion 5	24.8	29.0	35.0	43.4	53.0
Domestic	12.8	15.5	16.0	18.2	19.9
Livestock	12.0	13.5	19.0	25.2	33.1
Subregion 6	12.5	13.8	16.2	20.6	25.0
Domestic	6.2	6.8	7.9	9.5	10.6
Livestock	6.3	7.0	8.3	11.1	14.4
Subregion 7	16.3	18.3	22.4	29.3	37.4
Domestic	8.4	9.2	11.3	14.4	18.0
Livestock	7.9	9.1	11.1	14.9	19.4
Subregion 8	8.9	8.7	8.8	10.7	12.2
Domestic	6.7	5.7	5.8	6.7	7.0
Livestock	2.2	3.0	3.0	4.0	5.2
Subregion 9	16.3	18.5	23.1	29.7	36.9
Domestic	11.8	13.8	17.7	22.6	27.5
Livestock	4.5	4.7	5.4	7.1	9.4
Subregion 10	11.4	15.9	18.9	23.0	26.1
Domestic	11.4	12.9	15.2	18.0	19.7
Livestock	0	3.0	3.7	5.0	6.4
Subregion 11	8.5	9.8	12.6	18.6	26.6
Domestic	8.5	6.2	7.3	11.5	17.3
Livestock	0	3.6	5.3	7.1	9.3
Subregion 12	3.6	3.9	4.4	5.6	6.9
Domestic	0.7	1.1	1.2	1.3	1.2
Livestock	2.9	2.8	3.2	4.3	5.7
Total Region	184.8	209.8	249.0	314.1	387.1
Domestic	119.3	125.9	142.8	171.9	201.0
Livestock	65.5	83.9	106.2	142.2	186.1

Problems

Rural-domestic water supply problems are widespread, since the raw water supply must be of such quality that it can be used in the raw state or made acceptable with minimum treatment. Economic considerations alone will limit use of raw supplies that require extensive treatment such as disinfection, filtration, and/or softening to make them suitable for use.

Source development creates a number of problems. Shallow wells or springs may yield appreciable numbers of bacteria from human or animal wastes, and deep wells are often beyond the individual user's economic ability and may yield water highly mineralized, acidic, or with objectionable gasses such as hydrogen sulfide. Most surface waters in the region have turbidities which prohibit effective use of the waters by the rural community, and the individual developer is generally unable to supply adequate settling basins or cannot economically install long transmission lines to headwater areas for waters that need minimal treatment.

Stock-watering problems are expected to become significant in the future as larger numbers of animals are concentrated in feedlots of limited areas.

Oxides of nitrogen and increasing numbers of bacteria are appearing in water obtained from shallow wells. Water supplies must be adequately protected from sources of pollution, including the drainage from feedlots. Wells that are contaminated may have to be abandoned and new wells constructed in such a manner that surface or runoff water cannot enter. Abandoned wells should also be plugged and sealed properly to prevent further contamination of the ground-water formation.

Summary of Water Needs and Treatment Costs

Water Needs

A summary of total water supply needs for the region is shown in table 15. As indicated earlier, the values shown represent expected average use and should be considered a measure of total requirements, not peak demands. Conversion factors for cubic feet per second and acre-feet are given in the Glossary.

Table 15 - Summary of Total Water Use Projections, Columbia-North Pacific Region

Subregion	1965 (Base Year)	1970	1980 (MGD)	2000	2020
1	279.1	309.3	369.8	478.5	611.1
2	105.2	124.5	162.5	235.3	327.7
3	60.6	73.0	92.1	127.6	167.5
4	145.7	170.0	218.9	325.6	458.4
5	95.7	111.9	152.5	232.7	328.0
6	95.6	104.6	122.6	153.1	182.4
7	118.6	136.0	170.1	218.0	273.2
8	388.0	451.1	574.3	820.3	962.1
9	370.9	452.2	614.8	924.8	1,440.8
10	276.8	334.7	444.8	585.5	671.1
11	658.5	855.8	1,255.5	2,040.5	3,188.7
12	6.5	7.2	8.5	10.9	13.7
Total Region	2,601.2	3,130.3	4,186.4	6,152.8	8,624.7

Treatment Costs

A summary of expected total expenditures for water treatment in the region is presented in table 16. The capital costs represent the expenditure on treatment plant facilities required in each given year to provide plants capable of treating the quantity of water required 10 years in the future; assuming an average economic life of plant and equipment of 20 years and complete replacement in years 1980, 2000, and 2020. The "O & M" costs represent the expected annual expenditures for operation and maintenance of treatment plants of the sizes expected to be in service in the indicated years.

Costs for treatment of surface water supplies were derived from data contained in Reference 16. Costs for treatment of ground-water supplies were derived from information contained in Reference 10. The present ratios of surface water and ground-water supplies were taken from Reference 10 and assumed to remain the same in meeting future needs. The required treatment of surface waters was assumed to be coagulation, sedimentation, filtration, and disinfection. The required treatment for ground-water sources was assumed to be only disinfection. Industrial water supplies were assumed to be taken from surface sources.

Water treatment costs were also prepared in the Type 2 studies for Subregions 9 and 11. These cost analyses were conducted independently and the methodology used in each was different from that used for this Appendix. For comparison purposes these data are presented at the bottom of table 16. For more detail on the Type 2 cost analyses, References 10 and 18 should be consulted.

Table 16 - Summary of Water Treatment Costs, Columbia-North Pacific Region

Subregion	1970 Capital	1970 O&M	1980 Capital	1980 O&M	1990 Capital	1990 O&M	2000 Capital	2000 O&M	2010 Capital	2010 O&M	2020 Capital	2020 O&M
	Municipal Water Treatment (Million Dollars)											
1	6.32	43.70	46.80	55.45	7.10	66.92	63.55	81.95	9.51	96.72	82.47	111.48
2	2.59	14.92	18.27	19.07	3.34	23.23	25.83	28.65	4.12	34.05	34.00	39.46
3	1.42	7.21	8.74	8.49	1.29	9.76	11.23	10.59	1.14	11.43	13.48	12.25
4	3.87	24.75	21.87	31.18	3.97	37.62	30.91	46.73	5.05	55.82	40.99	64.92
5	3.57	26.46	18.70	34.36	4.08	42.25	27.73	51.95	4.95	61.63	37.56	71.20
6	1.70	8.34	9.00	9.92	1.24	11.50	11.85	13.50	1.58	15.49	14.97	17.48
7	1.68	11.28	13.85	14.07	3.81	16.85	19.73	18.72	2.00	20.58	23.67	22.44
8	2.67	12.56	13.97	15.82	2.31	19.08	19.26	23.07	2.92	27.06	25.05	31.04
9	11.46	28.13	55.65	36.00	9.77	43.83	81.17	56.23	14.92	68.56	110.42	80.87
10	3.62	8.15	27.30	10.75	3.95	13.54	35.44	17.21	4.03	20.85	43.38	24.47
11	16.06	56.53	40.27	78.13	19.99	99.66	139.82	128.95	28.18	158.16	195.18	187.28
12	.22	1.32	.77	1.54	.11	1.76	.99	1.98	.99	2.20	1.16	2.42
Total	55.18	243.35	275.19	314.78	60.96	386.00	467.51	479.53	79.39	572.55	622.33	665.31
	Industrial Water Treatment											
1	3.44	2.75	34.15	2.83	1.12	2.89	36.70	2.98	1.38	3.07	39.41	3.15
2	2.87	1.70	21.12	1.89	2.26	2.07	27.23	2.27	2.40	2.45	30.60	2.63
3	1.85	.93	11.24	1.04	1.23	1.14	13.81	1.25	1.27	1.35	16.30	1.45
4	3.72	1.72	23.76	1.93	2.75	2.13	29.10	2.31	2.47	2.48	33.94	2.64
5	2.19	1.18	14.67	1.31	1.56	1.44	17.52	1.53	1.22	1.62	19.90	1.71
6	1.11	.98	12.12	1.03	.58	1.07	13.02	1.09	.31	1.11	13.62	1.13
7	3.94	2.10	25.23	2.22	1.40	2.33	28.38	2.46	1.67	2.59	31.65	2.71
8	8.27	4.10	63.64	4.55	6.88	4.98	74.42	5.22	3.76	5.46	81.84	5.69
9	12.36	7.23	63.88	7.79	4.52	8.32	70.81	8.56	2.32	8.79	75.38	9.01
10	11.11	2.64	65.07	2.71	4.15	2.76	71.19	2.85	1.89	2.92	74.91	2.99
11	23.61	8.32	132.02	9.96	21.66	11.40	183.90	13.42	26.79	15.16	235.31	16.73
12	-	-	-	-	-	-	-	-	-	-	-	-
Total	74.47	33.65	466.90	37.26	48.11	40.53	566.08	43.94	45.48	47.00	652.86	49.84

Cost Data Presented in Type 2 Studies for Subregions 9 and 11
(for comparison purposes)

Costs of Municipal and Industrial Water Supply Purification Facilities, Subregion 9 (18)

Year	Capital Costs ($ Millions)	Annual Operation and Maintenance Costs ($ Millions)
1965-1985	21.2310	1.7897
1985-2020	59.0600	4.9680

Selected Plan for Municipal and Industrial Water Supply, Subregion 11 (10)

Amortized Capital Cost ($ Millions)

Year	Supply and Transmission	Storage and Distribution	Total
1965	36.5	83.2	119.7
1980	89.3	266.7	356.0
2000	136.7	565.2	701.9
2020	214.7	901.7	1,116.4
Total	477.2	1,816.8	2,294.0

LOCATION MAP

SUBREGION 1

S U B R E G I O N 1

C L A R K F O R K - K O O T E N A I - S P O K A N E

INTRODUCTION

The Clark Fork-Kootenai-Spokane Subregion drains an area of 36,360 square miles in Montana, Idaho, and Washington. The subregion is bounded on the north by the Canadian line, on the east by the Continental Divide, and on the west and south by several drainage divides.

In general, the area is characterized by cold, wet winters and hot, dry summers; but the climate varies greatly with elevation and location. Annual precipitation varies from 10 to 70 inches. Relatively dry belts exist in the rain shadows of the mountain ranges, with greater precipitation on the western, windward slopes.

Seasonal distribution of streamflow is characterized by peak flows during May and June; and average flows for these 2 months are about three times the average annual flow. April and July flows are about equal to, or a little above, average annual flows. The other 8 months are characterized by low flows, approximately one-half of the average annual flows.

Mining, forestry, agriculture, and recreation are the principal areas of employment. The subregion has outstanding mineral resources that have been well developed, but large reserves of important minerals remain. The forest products industry utilizes the pine forests covering a large part of the area for production of pulp and paper, lumber, and plywood. Agricultural pursuits are oriented toward livestock raising. Recreational development is becoming increasingly important to the economy. Glacier National Park and nearly 10 million acres of other Federal land (mainly forest land), along with numerous lakes and rivers, provide excellent opportunities for outdoor recreation.

The present population is about 595,100 (see the "Future Needs and Means to Satisfy Needs" section of the Regional Summary), the third highest subregional total. Most of the people are concentrated in the major towns, with large areas only sparsely populated.

To facilitate the discussion of municipal, industrial, and rural-domestic water, the subregion (figure 2) is divided into

the Clark Fork, Flathead, Pend Oreille, Kootenai, and Spokane Subbasins. The major service areas are the Butte-Anaconda, Missoula, and Spokane areas, which contain about two-thirds of the subregion's total population.

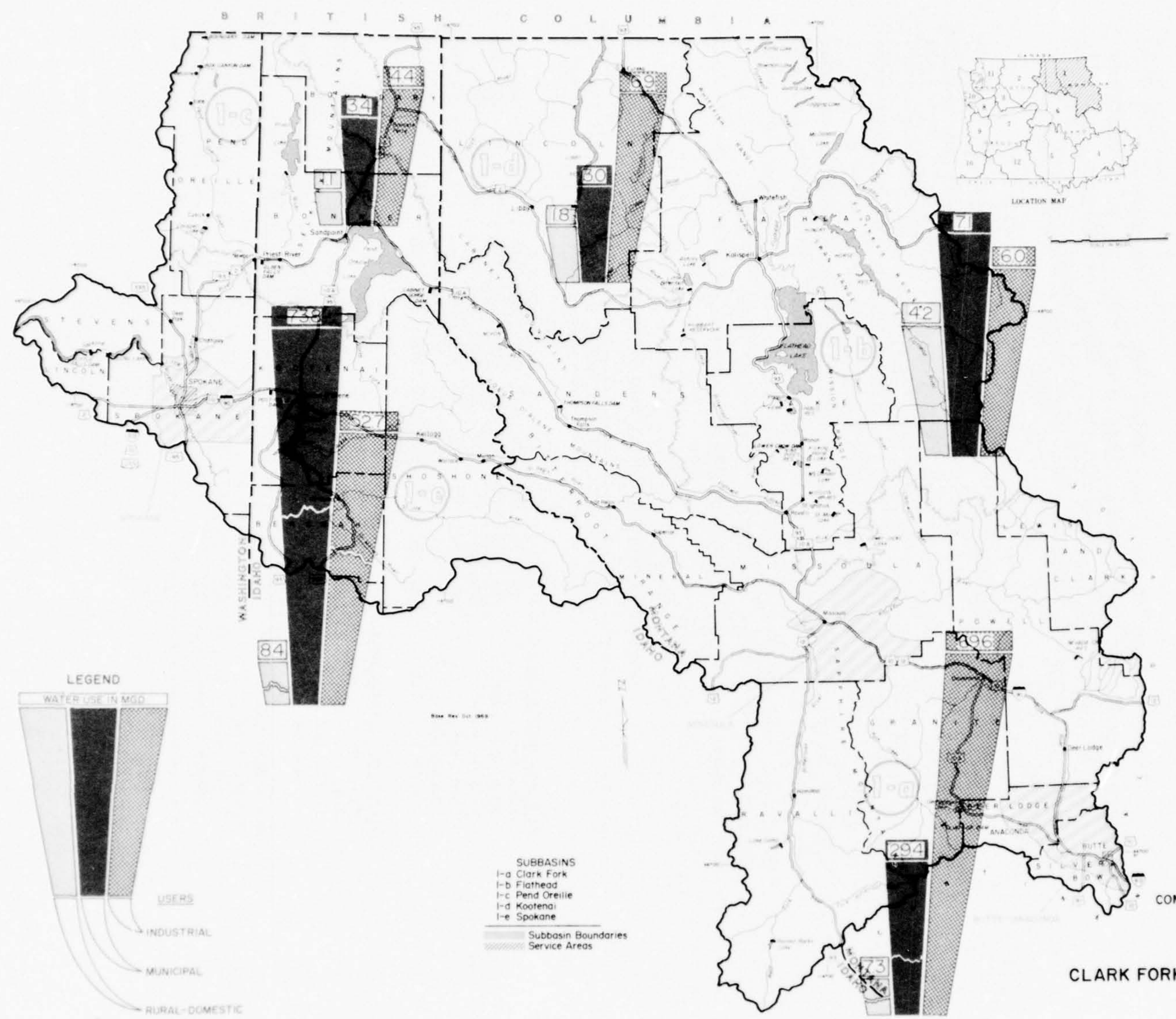
PRESENT STATUS

Table 17 is a summary of present (1965) average municipal, major industrial, and rural-domestic water, in million gallons per day, being used.

Table 17 - Present Municipal, Major Industrial, and Rural-Domestic Water Supply Needs, Subregion 1

	Municipal	Industrial	Rural-Domestic	Total	% Total Subregion
	--MGD--				
Clark Fork Subbasin					
Butte-Anaconda Service Area	15.2	45.0		60.2	21.6
Missoula Service Area	10.0	17.0	0.8	27.8	10.0
Other	4.2	7.6	6.5	18.3	6.5
	29.4	69.6	7.3	106.3	38.1
Flathead Subbasin	7.1	6.0	4.2	17.3	6.2
Pend Oreille Subbasin	3.4	4.4	1.1	8.9	3.2
Kootenai Subbasin	3.0	6.9	1.8	11.7	4.2
Spokane Subbasin					
Spokane Service Area	63.3	27.2	2.9	93.4	33.4
Other	10.5	25.5	5.5	41.5	14.9
	73.8	52.7	8.4	134.9	48.3
Total	116.7	139.6	22.8	279.1	100.0

At present, the municipal, major industrial, and rural-domestic water requirements average 279.1 mgd. The municipal and industrial needs are apportioned fairly equally (116.7 and 139.6 mgd, respectively), and the rural-domestic requirement is 22.8 mgd. These needs are generally concentrated in the major service areas. The Butte-Anaconda, Missoula, and Spokane Service Areas require about 67 percent of the subregion's average annual water needs.



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

WATER USE

CLARK FORK, KOOTENAI, SPOKANE SUBREGION I

1969

FIGURE 2

In the Spokane Subbasin, ground water is the principal source for supplying municipal and industrial requirements. Only a few communities use surface-water supplies. Most large industries in the Spokane Service Area have developed adequate independent ground-water supplies, and a relatively few are served by municipal facilities. In the remainder of the subbasin, municipal water sources are tributaries of major rivers and ground water.

The principal industrial water use is for lumber and wood products, pulp and paper, and primary metals. These industries use 30, 20, and 87 mgd, respectively. Water needs are generally provided by swift-flowing streams that supply dependable sources of water.

Table 18 summarizes major water-use categories in each of the service areas. The municipal monthly pattern for the Spokane Service Area is based on actual records. Since no data are available concerning the monthly municipal pattern in the other service areas, an analysis of water supply distribution for similar areas in the Pacific Northwest was used to derive the figures. In the Spokane Service Area, the maximum municipal water use occurs during the period of May through August. In the Butte-Anaconda and Missoula Service Areas, the peak demand occurs between June and September. The month of July is the maximum-use month for each of the service areas. The industrial seasonal variation is small,

Table 18 - Monthly Variation in Water Needs, Subregion 1

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	Percent											
Spokane Service Area												
Municipal	68	57	65	74	121	158	179	144	93	82	98	63
Pulp and paper	100	100	100	100	100	100	100	100	100	100	100	100
Primary metals	100	100	100	100	100	100	100	100	100	100	100	100
Food products	102	107	99	97	99	100	102	101	101	100	93	100
Lumber and wood products	100	100	100	100	100	100	100	100	100	100	100	100
Missoula Service Area												
Municipal	67	70	71	86	90	143	186	145	121	81	72	66
Pulp and paper	100	100	100	100	100	100	100	100	100	100	100	100
Lumber and wood products	100	100	100	100	100	100	100	100	100	100	100	100
Butte-Anaconda Service Area												
Municipal	67	70	71	86	90	143	186	145	121	81	72	66
Primary metals	100	100	100	100	100	100	100	100	100	100	100	100

because the major water-using industries of the subregion--processors of forest products and primary metals--operate continuously.

Water Quality

Surface Water

Generally, the surface waters of the subregion which are available for municipal and industrial purposes are of excellent quality. The principal exceptions are caused by the usual local bacterial contamination below municipalities, sediment and toxicity problems below mining operations, and turbidity and suspended sediment problems during the period of high runoff.

Most of the surface waters of the Kootenai, Pend Oreille, and Spokane Subbasins are excellent, insofar as dissolved mineral content is concerned. They are soft to moderately hard, and the dissolved solids concentrations seldom exceed 250 mg/l. The maximum dissolved solids concentration of the Clark Fork River above Missoula and of the Blackfoot River exceeds 250 mg/l at times. Acid mine wastes and tailings from ore concentration mills have degraded water quality in the Upper Clark Fork River (Silver Bow Creek) and in the South Fork of the Coeur d'Alene River. Except for the Coeur d'Alene River, all streams sampled have calcium, magnesium, and bicarbonate as the predominant ions. The Coeur d'Alene River contains larger percentages of sulfate as a result of drainage from the lead and zinc mines and processors located in the Coeur d'Alene drainage. The waters of most streams contain relatively small amounts of silica, generally less than 10 mg/l. The quality of surface waters representative of municipal sources is listed in table 19. In general, the waters meet requirements recommended by the Public Health Service Drinking Water Standards.

Very little suspended sediment concentration data are available for the subregion. The maximum recorded concentration of 840 mg/l has been observed on Flathead River at Columbia Falls, Montana. The only objectionable sediment concentrations generally occur below major mining operations such as those on the South Fork Coeur d'Alene River, or during periods of high runoff.

Bacterial quality of the streams in the area is highly variable. In general, coliform densities below service areas are high enough to produce conditions unsuitable for water-contact recreation. Specific areas of concern include the South Fork Coeur d'Alene River, with concentrations up to 24,000 organisms/100 ml; the Spokane River from Millwood to Long Lake, with levels up to 34,000 organisms/100 ml; and Ashley Creek below Kalispell, with levels up to 390,000 organisms/100 ml, recorded in 1957.

Table 19 - Summary of Water Quality Data for Surface Water, Subregion 1

	River Mile	D.O. (mg/l)	T (°C)	Coliform MPN/ 100 ml	pH	Color (PT-CO) (Units)	Hard. (mg/l)	Turb. (JTU)	TDS (mg/l)	Ortho PO_4 (mg/l)	NO_3-N (mg/l)	Fe (mg/l)
Clark Fork Subbasin												
Little Blackfoot River at Garrison	745.5-445.7-2.0											
Mean		--	--	--	8.0	--	158	--	195	--	0.15	0.33
Min.		--	--	--	7.6	--	78	--	108	--	0.00	0.00
Max.		--	--	--	8.3	--	385	--	582	--	0.90	2.10
Blackfoot River near Bonner	745.5-364.6-2.0											
Mean		9.5	--	--	8.1	--	125	--	132	--	0.10	0.27
Min.		8.6	1.7	--	7.8	--	83	--	112	--	0.00	0.00
Max.		11.6	15.0	--	8.4	--	165	--	152	--	0.50	1.06
Bitterroot River near Missoula	745.5-350.5-1.C											
Mean		9.8	--	--	7.8	--	90	--	71	--	0.07	0.30
Min.		8.0	3.3	--	7.3	--	31	--	46	--	0.00	0.00
Max.		11.8	14.5	--	8.2	--	110	--	122	--	0.40	1.06
Flathead Subbasin												
Flathead River at Columbia Falls	745.5-245.0-143											
Mean		--	--	--	7.5	--	88	--	101	--	0.27	0.002
Min.		--	--	--	7.1	--	69	--	89	--	0.00	0.00
Max.		--	--	--	8.0	--	107	--	123	--	1.40	0.06
Flathead River at Kerr Dam	745.5-245.0-72											
Mean		--	--	--	--	--	102	--	100	--	0.18	0.20
Min.		--	--	--	--	--	88	--	86	--	0.00	0.00
Max.		--	--	--	--	--	126	--	142	--	0.50	1.16
Pend Oreille Subbasin												
Pend Oreille River at Newport	745.5-88.3											
Mean		10.9	9.9	453	7.8	4	79	3	94	0.027	0.05	--
Min.		7.6	0.0	0	7.0	0	64	0	74	0.000	0.00	--
Max.		15.0	24.0	24,000	8.8	10	87	15	106	0.360	0.27	--
Pend Oreille River at Waneta, B.C.	745.5-0.1											
Mean		12.1	10.4	68	7.8	3	78	8	94	0.018	0.05	--
Min.		8.6	0.5	0	7.5	0	67	0	77	0.000	0.00	--
Max.		16.8	20.8	230	8.2	5	88	40	102	0.040	0.14	--
Spokane Subbasin												
Spokane River at Otis Orchards	643.0-96.3											
Mean		10.6	11.3	6,226	7.1	4	20	1	38	0.04	0.04	--
Min.		7.2	0.0	0	6.3	0	16	0	30	0.00	0.00	--
Max.		14.0	27.0	240,000	7.4	10	24	5	46	0.11	0.14	--
Little Spokane River at Dartford	643.0-56.3-11.4											
Mean		10.7	10.0	1,998	7.7	9	91	13	127	0.10	0.36	--
Min.		7.8	0.0	0	7.1	0	48	0	89	0.04	0.00	--
Max.		13.7	23.0	24,000	8.4	30	121	100	154	0.25	0.95	--
Spokane River at Long Lake	643.0-33.3											
Mean		9.2	9.9	708	7.2	7	63	22	86	0.16	0.42	--
Min.		2.9	0.5	0	6.6	0	27	0	45	0.05	0.07	--
Max.		14.5	19.6	4,600	7.8	15	104	260	125	0.44	0.79	--

Although data are lacking, Silver Bow Creek is assumed to have high bacterial concentrations since it receives mine waste and raw sewage from Butte, Montana.

Ground Water

The mineral quality of ground-water supplies for selected communities is listed in table 20. Most of the samples collected were of good quality. The constituent most commonly exceeding the recommended limit was iron. Excessive iron content is liable to impart tastes to beverages and cause staining of laundry and plumbing fixtures.

Table 20 - Mineral Water Quality of Ground-Water Supplies, Subregion 1

		SiO_2	Fe	Ca	Mg	Na	HCO_3	SO_4	Cl	NO_3	Total Solids	Hard. $CaCO_3$	F	pH
		Milligrams per liter (mg/l)												
Spokane, Wn. (Well 4)	7/26/61	12	0.00	34	16	3	168	14	2	4.6	171	150	0.1	7.9
(Well 5)	7/26/61	12	0.00	33	16	3	166	15	2	4.3	168	150	0.1	8.0
Post Falls, Idaho		--	0.05	22	8	3	84	7	2	--	112	89	0.0	8.2
Plummer, Idaho		--	--	18	11	3	90	5	0	--	158	90	0.2	8.0
Anaconda, Montana	4/2/57	13	0.01	46	10	4	181	17	1	1.6	181	156	0.4	7.7
St. Ignatius, Montana	9/9/63	--	0.2	53	8	0	195	3	2	0.9	158	165	2.0	--
Dayton, Montana	2/28/63	--	0.44	62	16	50	372	11	8	0.0	350	220	0.0	--
Arlee, Montana		--	0.70	42	7	3	165	0	2	0.0	124	132	0.0	--

A number of small private wells tested in the Bitterroot and Flathead Valleys in Montana were of good quality, although hard. However, a few had dissolved solids, nitrate, and iron concentrations in excess of those recommended by the Public Health Service for drinking water supplies. In all cases these excesses occurred in private supplies and, therefore, are mainly of local concern.

Although the chemical quality of ground water in the Spokane and Missoula areas is good, contamination of aquifers by ground disposal of domestic septic tank wastes is a potential problem.

Treatment

A summary of municipal water treatment practices in Subregion 1 is presented in table 21. Mineral removal and specialized treatment are not listed. Treatment of water supplies, especially ground water, is not extensive. Most surface or mixed supplies receive disinfection, and a small number receive complete treatment. Only about 20 percent of the municipal facilities utilizing

ground-water supplies practice disinfection; however, these facilities serve 73 percent of the population depending upon underground sources.

Table 21 - Summary of Municipal Water Sources and Treatment Practices, Subregion 1

Source	Number of Municipal Facilities	Population Served Thousands	Percent of Total Population
Ground			
No treatment	29	75.6	16.1
Disinfection	11	208.5	44.5
Complete	-	-	-
	40	284.1	60.6
Surface			
No treatment	4	2.3	0.5
Disinfection	22	93.1	19.9
Complete	2	9.8	2.1
	28	105.2	22.5
Mixed			
No treatment	2	2.2	0.5
Disinfection	13	76.9	16.4
Complete	-	-	-
	15	79.1	16.9
Total	83	468.4	100.0

Clark Fork Subbasin

Municipal

Approximately 118,350 persons, or 79 percent of the population in the Clark Fork Subbasin, are served by municipal water systems. An average annual demand of 29.4 mgd is exerted by the municipal population. The Butte-Anaconda and Missoula Service Areas use 15.2 and 10.0 mgd, respectively, or about 86 percent of the municipal demand.

Municipal water needs are supplied almost entirely from springs, wells, and the headwaters of tributaries of the Clark Fork River. Butte obtains water from Big Hole River and several

small creeks. Anaconda utilizes water from several creeks, lakes, and wells. Most waters in this subbasin receive settling and disinfection before use.

The City of Missoula withdraws from wells and Rattlesnake Creek. The City is located over a large aquifer that should easily meet any existing or future water demands of the area. However, some shortages have occurred during the summer irrigation period because the existing pumping, storage, and distribution facilities are inadequate to deliver maximum demands during those periods. In addition, the bacteriological quality of Rattlesnake Creek is consistently lower than that recommended by the Public Health Service Drinking Water Standards.

Industrial

The industrial water requirement in the Clark Fork Subbasin is about 69.6 mgd. The principal water-using industries are processors of primary metals and pulp and paper. These industries have average water needs of 46.3 and 14.0 mgd, respectively. The lumber and wood products industry uses about 9.3 mgd.

The largest use of water for industrial purposes is in the Butte-Anaconda Service Area. The primary metals industries utilize about 45 mgd, or 65 percent of the subbasin's total average industrial water demand.

In the Missoula Service Area, the pulp and paper industry uses 14 mgd. A plywood mill and several lumber mills use about 3.0 mgd.

Large lumber mills at Bonner, Superior, and Darby utilize 2.5, 1.0, and 1.2 mgd, respectively. A number of smaller mills scattered throughout the subbasin have a combined water demand of 1.5 mgd.

Rural-Domestic

The rural-domestic water demand in the subbasin is approximately 7.3 mgd, including 3.9 mgd for domestic purposes and 3.4 mgd for livestock watering.

About 31,450 persons, or 21 percent of the subbasin population, are served by individual water systems. The major sources of water for rural-domestic use are springs, wells, and tributaries of major rivers. There is no known significant problem with the quality or quantity of water available for rural-domestic

purposes; however, contamination of aquifers by ground disposal of domestic septic tank wastes is a potential problem in the Missoula area.

Flathead Subbasin

Municipal

Municipal water facilities serve 28,760 persons, or 59 percent of the Flathead Subbasin population. Municipalities have an average annual water need of 7.1 mgd. The largest water user is the City of Kalispell, with a need of 2.8 mgd. Whitefish and Polson use 1.3 and 1.0 mgd, respectively.

Most municipalities utilize water from wells and tributaries of the Flathead River. The only community obtaining water from Flathead Lake is Somers. The City of Kalispell relies upon ground-water sources, and Columbia Falls obtains water from Cedar Creek. The only other major towns (Polson, Whitefish, St. Ignatius, and Ronan) take surface water from tributaries of the Flathead River.

Industrial

At the present time, industrial use of water is relatively small. The primary metals industry uses about 2.0 mgd from the Flathead River for cooling purposes. A number of sawmills and plywood mills at Kalispell, Polson, Whitefish, and other small towns utilize an estimated 4.0 mgd.

Rural-Domestic

The rural-domestic water requirement amounts to approximately 4.2 mgd. About 2.6 mgd are used for domestic purposes and 1.6 mgd for livestock watering.

Approximately 19,940 persons, or 41 percent of the Flathead Subbasin population, are served by individual water systems. Most water is obtained from wells and tributaries of the Flathead River. Neither quantity nor quality limits water use for rural-domestic purposes.

Pend Oreille Subbasin

Municipal

Approximately 13,390 persons, or 72 percent of the Pend Oreille Subbasin population, are served by municipal water systems. The municipal population has an average water need of 3.4 mgd. Most of the municipal use is centered near the communities of Newport, Washington, and Priest River and Sandpoint, Idaho, which serve a combined population of 10,500. This area requires nearly 80 percent of the subbasin's average municipal water need.

The Pend Oreille River and its tributaries are the only major sources of municipal water. The communities of Priest River and Dover, Idaho, and Usk and Cusick, Washington, obtain water from the Pend Oreille River. The remainder of the communities utilize tributaries of the Pend Oreille River or Pend Oreille Lake as a source of water.

The City of Sandpoint provides complete treatment of its water supply.

Industrial

Most industrial water in the Pend Oreille Subbasin is developed from independent surface sources. The primary metals industry uses 2.8 mgd of the 4.4 mgd industrial water need for the area. Minor industrial uses include numerous sawmills and a cement plant at Metaline Falls.

Rural-Domestic

The rural-domestic water need in the subbasin is approximately 1.1 mgd, including 0.7 mgd for domestic purposes and 0.4 mgd for livestock watering. Most of the water utilized for rural-domestic purposes is from the Pend Oreille River and tributaries, and Pend Oreille Lake.

Kootenai Subbasin

Municipal

The Kootenai Subbasin is sparsely populated, with only 11,930 persons, or 49 percent of the population, served by municipal facilities. The average annual municipal water need for the entire subbasin is only 3.0 mgd. The major municipalities are

Libby and Bonners Ferry, with average annual water needs of 1.5 and 0.7 mgd, respectively.

Tributaries of the Kootenai River and ground water are the major sources of water. Most municipalities provide at least chlorination of water supplies. Bonners Ferry provides auxiliary coagulation, sedimentation, and filtration when the Kootenai River must be used as a water supply.

The quantity of municipal water in the subbasin is abundant since, in general, the water passes through unused for consumptive purposes. There are little available quality data, but it appears that the water is usually satisfactory for all municipal purposes.

Industrial

Industrial water use in the Kootenai Subbasin is primarily by the lumber and wood products industry, which needs an estimated 6.9 mgd. The largest individual user is the pulp and paper industry, which requires approximately 5.0 mgd. A number of smaller lumber mills have a combined water need of 1.9 mgd.

The only other industries in the subbasin with significant water requirements are mining operations. Zonolite recently employed recirculation and reduced water consumption from 1,000 gpm to 100 gpm. No data are available concerning water use by the mining industries.

Rural-Domestic

The rural-domestic water demand is about 1.8 mgd, including 1.5 mgd for domestic purposes and 0.3 mgd for livestock watering. Nearly 51 percent of the subbasin's population is served by individual water systems. In general, the sources of water for domestic purposes are tributaries of the Kootenai River or wells.

Spokane Subbasin

Municipal

This subbasin is the most densely populated area in Subregion 1 and also has the greatest demand for municipal water. Nearly 296,000 persons, or 84 percent of the subbasin population, are served by municipal water facilities. This creates an average annual demand of 73.8 mgd. Most of this demand is within the

Spokane Service Area, which requires 63.3 mgd. The City of Spokane alone uses an average of 47.5 mgd.

Significant municipal water uses also occur in the Coeur d'Alene and Wallace-Kellogg areas. These areas utilize 3.8 and 2.6 mgd, respectively.

Municipal water needs within the Spokane Subbasin are, in general, supplied either by springs or by the ample and high-quality ground water found in the Spokane Valley. The only exceptions are several communities in the Idaho portion of the subbasin which are supplied by lakes and small streams.

Communities obtaining water supplies from Hayden Lake have recently expressed concern about the quality of the lake. The major problem has been the rapid eutrophication of the lake, which has resulted in taste and odor problems as well as degradation of the aesthetic appearance.

Industrial

The industrial water requirement in the Spokane Subbasin is 51.2 mgd. The principal water users are the lumber and wood products, pulp and paper, and primary metals industries. These industries have average water needs of about 9.0, 6.5, and 35.7 mgd, respectively. Relatively small quantities of water are used by the food-processing industry.

The primary industrial use in the Idaho portion of the subbasin is for the mining industry. Mining operations in the South Fork Coeur d'Alene area require about 20 mgd. The lumber and wood products industry uses about 5.5 mgd.

In the Washington portion of the subbasin, most industrial water use is in the Spokane Service Area. The principal industries are pulp and paper manufacturing and aluminum processing. The water demand for these industries is about 6.5 and 15.7 mgd, respectively. In addition, the lumber and wood products and the food-processing industries use 3.5 and 1.5 mgd, respectively.

Industrial needs are usually supplied by ground water in the Spokane Valley. Tributary streams and ground water are the main sources of water in the Idaho portion of the subbasin. In either case, the sources are generally developed independently of municipal facilities.

Rural-Domestic

The rural-domestic water demand in the Spokane Subbasin is about 8.4 mgd. The large animal population uses about 1.1 mgd. The rural-domestic population of 57,760 persons has an average annual water demand of 7.3 mgd. The sources of water are ground water and tributaries of major streams. Both the quality and the quantity of water are adequate for present needs, except in the rural areas near Spokane. In this area, contamination of aquifers by ground disposal of domestic septic tank wastes is a potential problem.

FUTURE NEEDS AND MEANS TO SATISFY NEEDS

The principal factors that will determine future water needs in Subregion 1 are population growth and industrial expansion, particularly in primary metals and pulp and paper production. As these increase, the need for water will likewise increase.

The estimated 1965 population of 595,000 in the subregion is projected to increase 92 percent--to 1.14 million by 2020. Table 22 shows the projected population by subbasin and service area for the years 1980, 2000, and 2020. Over three-fourths of the population will be centered in the Spokane, Missoula, and Butte-Anaconda Service Areas by 2020.

Production growth of the major water-using industries in the subregion is projected to increase by more than 387 percent between now and 2020 in terms of output. It is anticipated that primary metals and pulp and paper will continue to be the major industries between now and the year 2020. These industries will, by 2020, account for 55 percent of the total output by major water-using industries.

Municipal

Basis for Water Supply Projections

The projected population to be served by municipal water systems is shown in table 22. This projection indicates that by the year 2020 approximately 90 percent of the population will obtain water from central systems. The entire populations of the service areas are expected to be served by central systems by that time.

Table 22 - **Projected Population, Subregion 1**

	1980	2000	2020
	--------Thousands--------		
Clark Fork Subbasin	154.0	164.0	180.2
Butte-Anaconda Service Area	60.2	55.6	50.8
Municipal	60.2	55.6	50.8
Rural	-	-	-
Missoula Service Area	51.7	65.2	82.9
Municipal	48.7	65.2	82.9
Rural	3.0	-	-
Other	42.1	43.2	46.5
Municipal	16.6	17.2	20.0
Rural	25.5	26.0	26.5
Subtotal	154.0	164.0	180.2
Municipal	125.5	138.0	153.7
Rural	28.5	26.0	26.5
Flathead Subbasin	51.0	58.3	63.9
Municipal	30.5	36.8	41.9
Rural	20.5	21.5	22.0
Pend Oreille Subbasin	18.9	26.0	34.2
Municipal	13.6	18.1	23.4
Rural	5.3	7.9	10.8
Kootenai Subbasin	27.3	29.6	35.4
Municipal	15.1	18.0	25.7
Rural	12.2	11.6	9.7
Spokane Subbasin	447.9	619.2	826.8
Spokane Service Area	340.5	493.0	661.4
Municipal	325.5	488.0	661.4
Rural	15.0	5.0	-
Other	107.4	126.2	165.4
Municipal	68.9	82.2	119.4
Rural	38.5	44.0	46.0
Subtotal	447.9	619.2	826.8
Municipal	394.4	570.2	780.8
Rural	53.5	49.0	46.0
Total Subregion	699.1	897.1	1,140.4
Municipal	579.1	781.1	1,025.5
Rural	120.0	116.0	115.0

This subregion is in Climatic Designation 2, as defined in the "Future Needs" section of the Regional Summary, for determination of projected municipal per capita water consumption. The average demand is expected to be 275 gpcd by 1980, 295 gpcd by 2000, and 310 gpcd by 2020.

Projections of Water Supply Requirements

The anticipated municipal water requirements by subbasin and service area for the years 1970, 1980, 2000, and 2020, are presented in table 23. The present water use is forecast to increase to 319 mgd by 2020. By 2020, municipal requirements will account for approximately 52 percent of the total subregional needs. Future needs are expected to be concentrated in the major service areas. The Spokane Service Area is expected to require nearly 65 percent of the municipal needs by the end of the projection period.

Table 23 - Projected Municipal Water Use, Subregion 1

	1970	1980	2000	2020
	MGD			
Clark Fork Subbasin				
Butte-Anaconda Service Area	15.7	16.6	16.4	15.7
Missoula Service Area	11.1	13.4	19.2	25.7
Other	4.3	4.6	5.2	6.3
	31.1	34.6	40.8	47.7
Flathead Subbasin	7.6	8.5	11.0	13.2
Pend Oreille Subbasin	3.8	4.6	5.4	7.4
Kootenai Subbasin	3.2	3.5	5.4	8.1
Spokane Subbasin				
Spokane Service Area	72.0	89.4	141.0	205.0
Other	13.4	19.3	24.7	37.6
	85.4	108.7	165.7	242.6
Total	131.1	159.9	228.3	319.0

Problems and Solutions

While the steadily mounting need for water will not strain the abundant water resources in the subregion, localized supply difficulties are certain to emerge. Although the total supply of water is available to meet needs well into the next century, storage capacity must be developed to assure that the supply is available at the required time in the place of need. Since most surface supplies are from headwater areas, water supplies will be of sufficient quality that treatment beyond chlorination will be minimal.

For several areas that use ground-water supplies, bacterial contamination will continue to be a problem, particularly where septic tank systems are used. A major problem facing the suburban areas of Spokane and Missoula is the contamination of individual and municipal ground-water supplies by individual subsurface disposal of domestic wastes. Individual systems normally function satisfactorily in areas that are not heavily populated but, as the areas become more populous, the chances of contaminating the aquifer become greater. The obvious solution is to provide the areas with sanitary sewers and water distribution systems. The general practice is to annex the suburbs to cities and extend the municipal facilities. If political barriers do not allow the extension of municipal water and sewer facilities, a district must be established or the services of private utilities should be sought.

In suburban Spokane, there are over 40 domestic water systems operating independently with no central agency that controls or coordinates the activities of the many water suppliers. Although duplication of water service has not become a great problem, the cases that do exist could have been avoided by pre-planning.

Industrial

Basis for Water Supply Projections

As previously discussed, projected industrial water use is the product of a growth index and the present water use. The forecast growth indices for the major water-use categories in the subregion are shown in table 24 for the years 1980, 2000, and 2020. The indices are derived from data presented in Appendix VI.

Table 24 - Industrial Growth Indices, Subregion 1

	1980	2000	2020
	(Base Year 1963 = 1.00)		
Primary metals	1.29	1.44	1.74
Pulp and paper	1.95	3.29	3.59
Lumber and wood products	0.99	0.91	0.87
Food products	1.43	2.03	2.84

Projections of Water Supply Requirements

Projected water needs by major industrial categories are presented in table 25 for the years 1970, 1980, 2000, and 2020. By 2020, industrial needs will be about 248 mgd, or 40 percent of the total water needs in the subregion.

Table 25 - Projected Industrial Water Use, Subregion 1

	1970	1980	2000	2020
	MGD			
Pulp and paper	30.7	36.2	58.2	65.0
Food products	1.6	1.9	2.7	3.7
Primary metals	95.8	113.2	126.2	152.7
Lumber and wood products	25.2	29.7	27.3	26.1
Total	153.3	181.0	214.4	247.5

The primary metals and the pulp and paper industries will continue to be the major water users, requiring approximately 153 and 65 mgd, respectively, by 2020. The water needed for the lumber and wood products industry is expected to decrease slightly during the projection period. The food products industry will continue to be a relatively minor water user.

In general, increases in water use will occur at existing operations for most industries. However, it seems probable that the pulp and paper and the primary metals industries will develop new sites during expansion. There are several sites in the Montana portion of the subregion which could support a new pulp mill with

a capacity of 1,000 tons/day. The most feasible of these sites appear to be in the Plains area along the Clark Fork River and in the Libby area near the Kootenai River. The headwater areas of the Blackfoot and Bull Rivers are currently being considered as locations for future primary metals operations.

Problems and Solutions

Sufficient quantities of water are available in the subregion to meet the projected industrial water requirements, and no problems are anticipated. However, there may be isolated situations requiring storage to meet peak demands.

Rural-Domestic

Basis for Water Supply Projections

The projected population which will rely on individual water systems is shown in table 22 presented earlier. The projections show that only about 10 percent of the population will be served by individual systems by 2020.

Based on assumptions presented in the "Future Needs" section of the Regional Summary, the expected water consumption for the rural population will be 165 gpcd in 1980, 205 gpcd in 2000, and 250 gpcd in 2020.

The projected livestock population in the subregion is based on data presented in Appendix VI. It has been assumed for purposes of this study that the livestock water use per animal will remain constant during the projection period.

Projections of Water Supply Requirements

The anticipated rural-domestic water requirements are presented by subbasin for the years 1970, 1980, 2000, and 2020 in table 26. The rural-domestic needs are forecast to increase to about 44.6 mgd by 2020, of which approximately 28.7 mgd will be required for domestic purposes and 15.9 mgd for livestock watering.

Problems and Solutions

Rural-domestic needs are scattered throughout the basin. In general, there is adequate water to satisfy the projected rural-domestic needs. The problem of bacterial contamination

of ground-water supplies from increased use of septic tank and absorption systems and also feedlots is expected to continue in some areas. These problems can be best alleviated on an individual basis.

Table 26 - Projected Rural-Domestic Water Use, Subregion 1

	1970	1980	2000	2020
	MGD			
Clark Fork Subbasin				
Domestic	4.0	4.7	5.3	6.6
Livestock	4.0	4.6	6.1	8.0
	8.0	9.3	11.4	14.6
Flathead Subbasin				
Domestic	2.8	3.4	4.4	5.5
Livestock	1.8	2.1	2.8	3.7
	4.6	5.5	7.2	9.2
Pend Oreille Subbasin				
Domestic	0.8	0.9	1.6	2.7
Livestock	0.4	0.5	0.7	0.9
	1.2	1.4	2.3	3.6
Kootenai Subbasin				
Domestic Live	1.7	2.0	2.4	2.4
Livestock	0.3	0.4	0.5	0.7
	2.0	2.4	2.9	3.1
Spokane Subbasin				
Domestic	7.8	8.8	10.0	11.5
Livestock	1.3	1.5	2.0	2.6
	9.1	10.3	12.0	14.1
Total				
Domestic	17.0	19.8	23.7	28.7
Livestock	7.9	9.1	12.1	15.9
	24.9	28.9	35.8	44.6

LOCATION MAP

SUBREGION 2

S U B R E G I O N 2

U P P E R   C O L U M B I A

INTRODUCTION

Subregion 2, in north-central Washington, contains 22,451 square miles. It is composed of the areas draining into the Columbia River above Pasco, except those drained by the Yakima and Spokane Rivers. The Canadian line is the northern boundary, positioned across several north-south trending mountain ranges which make up the Okanogan Highlands. To the west is the Cascade Range, rising to elevations of nearly 10,000 feet. In the central and southern portions of the subregion are the Channelled Scablands, an area of scoured canyons caused by a sudden outbreak of glacial melt-water during the Ice Age. The southeastern corner borders on the Palouse Hills.

Climatic conditions are variable. Summers in the southern areas are relatively hot, with temperatures of 90 to 100°F. common. The highlands of the northern and western sections are generally somewhat cooler. Winters, sometimes under the influence of extensive Arctic airmasses, are cold, with readings to -40°F. having been recorded. In the Cascade Range, precipitation totals over 80 inches, with annual snow cover of over 100 inches. Both snow and total precipitation decrease eastward and southward to a low of less than 10 inches of annual precipitation in the Channelled Scablands.

Stream runoff is greatest during the period from December to April and is lowest in August. Extreme variations commonly occur from May to August.

The major employment is related to agriculture. There are a limited number of canning, freezing, and dairy processing plants; an aluminum plant; and several primary metals and mining operations. Recreation is an important economic activity that will probably become increasingly significant.

The subregional population is about 250,200 persons. Four major urban areas contain about 35 percent of the people. In addition, small towns and villages are scattered throughout the southern sections. Communities are not as numerous in the north.

The major municipal and industrial water-use centers in the Upper Columbia Subregion (figure 3) are the Tri-Cities Service Area, including the cities of Pasco, Kennewick, and Richland; the Wenatchee urban area; the Moses Lake area; and the Okanogan-Omak area. The cities of Richland and Kennewick are not in this subregion but are so economically and physically interrelated with Pasco that they can be considered together as a service area.

PRESENT STATUS

A summary of present municipal, major industrial, and rural-domestic water currently being used is presented in table 27. At present, the requirements average about 105.2 mgd, including a municipal demand of 42.4 mgd, an industrial demand of 46.8 mgd, and a rural-domestic demand of 16.0 mgd. The industrial water requirement does not include that of the Hanford Atomic Works.

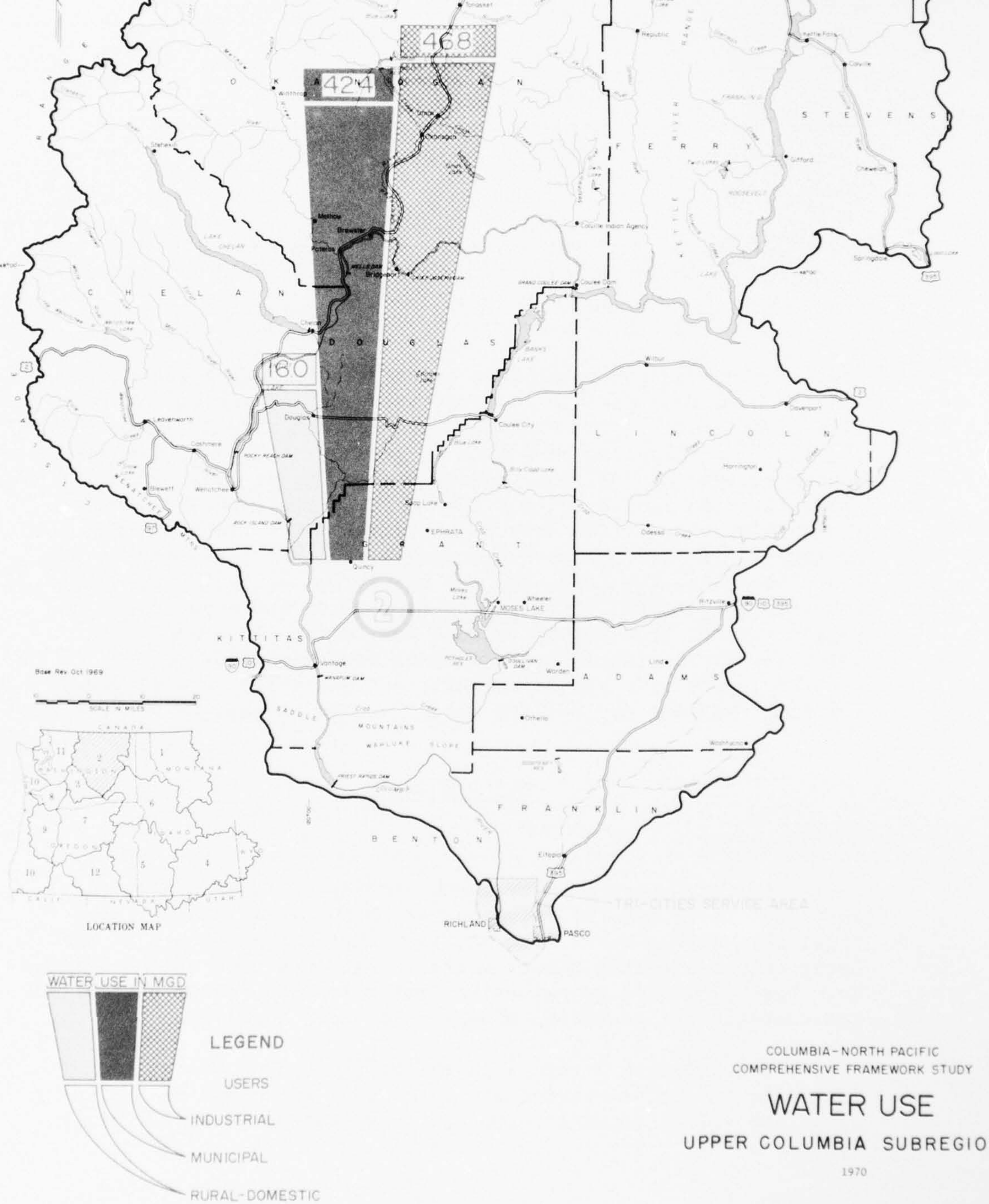
Table 27 - Present Municipal, Major Industrial, and Rural-Domestic Water Supply Needs, Subregion 2

	Municipal	Industrial	Rural-Domestic	Total	% Total Subregion
	MGD				
Tri-Cities Service Area	14.8	-	1.7	16.5	15.7
Other	27.6	46.8	14.3	88.7	84.3
Total	42.4	46.8	16.0	105.2	100.0

The principal water-using industries are primary metals, food processing, and wood and lumber products. They require 38, 30, and 27 percent, respectively, of the average annual industrial water requirement.

With the exception of concentrated municipal water-use centers in the Tri-Cities Service Area, and the Wenatchee, Moses Lake, and Okanogan-Omak areas, the municipal demand is scattered throughout the subregion. Approximately 59 percent of the municipal water use occurs in these areas.

Table 28 summarizes annual distribution of monthly requirements for the major water-use categories in each of the principal



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

WATER USE

UPPER COLUMBIA SUBREGION 2

1970

FIGURE 3

Table 28 - Monthly Variation in Water Needs, Subregion 2

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
						Percent						
Tri-Cities Service Area												
Municipal	67	70	71	86	90	143	186	145	121	81	72	66
Industrial*												
Wenatchee Area												
Municipal	67	70	71	86	90	143	186	145	121	81	72	66
Industrial												
Food processing	69	63	63	69	103	125	143	134	111	126	107	87
Primary metals	100	100	100	100	100	100	100	100	100	100	100	100
Pulp and paper	100	100	100	100	100	100	100	100	100	100	100	100
Moses Lake Area												
Municipal	67	70	71	86	90	143	186	145	121	81	72	66
Industrial												
Food processing	159	100	100	100	68	2	2	35	131	161	170	172
Okanogan-Omak Area												
Municipal	67	70	71	86	90	143	186	145	121	81	72	66
Industrial												
Food processing	77	89	82	113	81	100	108	98	99	170	114	69
Lumber & wood products	100	100	100	100	100	100	100	100	100	100	100	100

*No data available.

areas. Since insufficient data are available concerning the monthly municipal pattern in these areas, a statistical analysis of similar areas in the Pacific Northwest was used to derive the figures. Municipal water demand is greatest from June through September, and the maximum monthly demand during this period is generally from 120 to 185 percent of the average monthly demand. There is usually little seasonal water-use variation for the primary metals and the wood and lumber products industries. On the other hand, the food products industries have distinct water requirement patterns. The potato-processing and sugar-refining season extends from August through May, while the demand for water for fruit processing is maximum from September through December, primarily because significant quantities are required for fruit washing and cooling water in cold storage warehouses.

Water Quality

Surface Water

Surface water quality in the subregion is generally excellent, but there are two water quality problems at present--the algal activity in Moses Lake and the temperature regimen of the Upper Columbia during summer months. Although some of the streams have been subjected to extensive irrigation use, their suitability for domestic or industrial uses has not been impaired.

The Columbia River as it enters the United States from Canada is a calcium-bicarbonate type water which has an average dissolved solids concentration of approximately 90 mg/l. Daily

samples collected at the International Boundary (Northport, Washington) since 1952 have had a dissolved solids range of 71 to 158 mg/l. The water is moderately hard, ranging from 62 to 128 mg/l hardness, and has taste and odor problems which conventional treatment does not remove. The dissolved solids content of the streams entering from the western elevations of the Cascade Range averages less than 60 mg/l. Those streams which drain the areas north and east of the Upper Columbia River are more highly mineralized, primarily because there is extensive irrigation, but also because the land is arid and the availability of natural soluble minerals is greater. For these streams (Sanpoil, Okanogan, and Colville Rivers and Crab Creek), the average dissolved solids concentration is greater than 125 mg/l and, in the case of Crab Creek, greater than 500 mg/l. The water of these tributaries is a calcium-magnesium bicarbonate type and has a larger percentage of sulfate than those tributaries which drain the western part of the subregion. The quality of surface waters representative of municipal sources is listed in table 29.

Dissolved oxygen concentrations in the rivers and streams of this subregion are routinely near saturation at all locations. Occasional dips do occur seasonally, but do not constitute any significant degradation of water quality. Oxygen levels near the bottom of Moses Lake, determined in the summer of 1963, ranged from 2.7 to 7.3, apparently due to the oxygen demand of intense algal growths in the lake. Coliform densities vary widely and below many communities reach levels which render watercourses unsuitable for municipal or food-processing purposes without extensive treatment. However, these adverse conditions are localized and do not indicate a widespread problem. It is believed that high coliform densities occurring in the lower reaches of Crab Creek are attributable, in large part, to cattle pastured on adjacent land. Algal growths interfering with uses of Moses Lake result from abundant nutrient input to the lake. This nutrient load is derived from both natural and man-made sources. In addition to aesthetically degrading quality, these organisms also exert a significant demand on the oxygen resources of the lake.

The Columbia River below the Hanford Atomic Works has a mean beta count of 583 picocuries per liter (pc/l). The maximum level has not exceeded the PHS Drinking Water Standard of 1,000 pc/l since November 1964. Levels of zinc-65 and phosphorus-32 approximate 100 to 200 pc/l in the Columbia River below Hanford.

A significant change in water temperature of the Columbia River occurs in the subregion. The increase in temperature is attributed to the numerous impoundments on the main stem and to the discharge of cooling waters from the Hanford Atomic Works.

Table 29 - Summary of Water Quality Data for Surface Water, Subregion 2

	River Mile	D.O. (mg/l)	T (°C)	Coliform MPN/ 100ml	pH	Color PT-CO (Units)	Hard. (mg/l)	Turb. (JTU)	TDS (mg/l)	Ortho PO_4 (mg/l)	NO_3-N (mg/l)
MAIN STEM COLUMBIA											
Northport, Washington											
Mean		11.5	9.8	385	7.6	4	78	17	--	.05	.05
Min.		10.4	1.6	240	6.6	0	50	0	--	.01	.00
Max.		12.4	17.5	560	8.4	25	159	32	--	.18	.11
Wenatchee, Washington											
Mean		11.8	11.0	310	8.0	5	66	4	--	.03	.07
Min.		8.0	2.5	2	6.9	0	50	0	--	.01	.00
Max.		15.5	21.6	7,300	8.6	25	112	25	--	.04	.14
Columbia River below Priest Rapids Dam											
Mean		11.9	11.4	131	7.7	5	69	3	--	.08	.10
Min.		9.5	3.0	0	7.5	0	62	0	--	.03	.02
Max.		14.0	18.5	430	7.9	5	81	20	--	.15	.27
Columbia River, Pasco, Washington											
Mean		10.8	12.2	182	8.1	8	73	15	--	.01	.19
Min.		6.8	3.0	1	6.8	0	40	0	--	.01	.05
Max.		14.3	22.0	4,800	8.6	68	90	140	--	.02	.37
Columbia River below Rock Island											
Mean		12.3	10.6	691	7.8	8	2	4	--	--	.10
Min.		9.8	1.5	10	7.2	3	8	1	--	--	.01
Max.		15.9	18.0	8,000	8.4	15	2	32	--	--	.19
TRIBUTARIES											
Kettle River near Barstow, Wash.	706.4-10.3										
Mean		11.2	9.8	603	7.8	7	68	2	94	0.01	0.05
Min.		7.9	0.0	0	6.9	0	20	0	39	0.00	0.00
Max.		14.5	25.0	11,000	8.7	30	110	10	141	0.07	0.11
Colville River at Kettle Falls, Wash.	695.0-5.3										
Mean		10.5	10.4	4,774	7.9	9	165	25	204	0.20	0.37
Min.		7.3	0.0	0	7.6	5	108	5	141	0.01	0.02
Max.		13.8	24.0	46,000	8.7	30	202	140	260	0.51	1.49
Sanpoil River at Keller, Wash.	616.0-12.2										
Mean		11.1	8.8	901	7.8	6	85	3	128	0.14	0.06
Min.		7.8	0.3	0	7.3	0	51	0	98	0.03	0.00
Max.		13.6	25.0	11,000	8.8	20	106	15	156	0.95	0.16
Okanogan River at Oroville, Wash.	533.5-81.9										
Mean		11.0	11.5	52	8.0	4	126	1	168	0.02	0.05
Min.		8.4	1.2	0	7.4	0	109	0	149	0.00	0.02
Max.		13.2	26.0	430	8.5	10	136	5	178	0.04	0.11
Similkameen River at Oroville, Wash.	533.5-77.6-5.2										
Mean		11.0	11.7	99	7.7	6	72	3	100	0.02	0.03
Min.		8.2	0.8	0	7.1	0	32	0	52	0.01	0.00
Max.		14.5	23.0	930	8.1	20	99	15	132	0.09	0.09

Table 29 (Continued)

	River Mile	D.O. (mg/l)	T (^{o}C)	Coliform MPN/ 100ml	pH	Color (PT-CO) Units	Hard. (mg/l)	Turb. (JTU)	TDS (mg/l)	Ortho PO_4 (mg/l)	NO_3-N (mg/l)
Okanogan River near Brewster, Wash.	533.5-1.4										
Mean		10.9	11.5	4,699	7.8	6	101	6	137	0.05	0.05
Min.		5.8	0.0	0	7.1	0	38	0	59	0.00	0.00
Max.		15.4	28.1	240,000	8.4	20	147	40	205	0.16	0.18
Methow River at Pateros, Wash.	523.9-0.5										
Mean		11.5	9.1	457	7.8	3	73	1	96	0.02	0.13
Min.		9.3	0.0	0	6.9	0	28	0	45	0.00	0.00
Max.		14.2	20.5	9,300	8.4	10	101	10	130	0.20	0.32
Chelan River at Chelan, Wash.	503.2-2.9										
Mean		10.5	12.7	259	7.2	2	20	1	32	0.01	0.04
Min.		8.6	4.5	0	7.0	0	19	0	27	0.00	0.00
Max.		12.1	23.8	2,400	7.5	5	21	10	38	0.04	0.09
Entiat River near Entiat, Wash.	483.7-6.2										
Mean		11.8	8.4	775	7.5	3	31	2	55	0.02	0.05
Min.		8.9	0.0	0	6.8	0	16	0	30	0.00	0.00
Max.		14.2	19.6	11,000	8.0	5	47	10	79	0.07	0.16
Wenatchee River near Leavenworth, Wash.	468.4-35.5										
Mean		10.9	8.1	667	7.1	5	13	1	28	0.01	0.04
Min.		4.2	0.1	0	5.8	0	8	0	20	0.00	0.00
Max.		13.6	22.2	24,000	7.4	10	16	5	37	0.03	0.20
Wenatchee River at Wenatchee, Wash.	468.4-1.1										
Mean		11.9	9.5	1,047	7.4	5	25	2	42	0.02	0.09
Min.		9.1	0.0	0	6.8	0	12	0	23	0.00	0.02
Max.		16.4	25.3	11,000	8.8	10	43	10	66	0.20	0.18
Crab Creek at Irby, Wash.	410.8-113.7										
Mean		11.6	8.4	738	8.1	11	143	92	234	0.44	1.37
Min.		9.0	1.0	36	7.6	5	99	0	187	0.29	0.75
Max.		13.6	16.8	2,900	8.5	50	175	410	280	0.74	2.49

Ground Water

There are two major aquifer units in Subregion 2 that yield large supplies of water to wells. One of these includes alluvial and glacial deposits occurring along most stream valleys north of and along the Columbia River. Where a moderate thickness of sand and gravel is penetrated, moderate to large supplies of water can be developed. The other is the Columbia River Group, which is the most important aquifer unit south of the Columbia River. This basalt is generally an excellent aquifer where several successive flows are in contact.

Water quality in the alluvial and glacial deposits is excellent in most cases. Dissolved solids usually range from 200 to 400 mg/l; hardness is generally from 100 to 250 mg/l; fluorides seldom exceed 0.7 mg/l; and the water is a calcium-magnesium bicarbonate type.

Water quality in the Columbia River Group is generally excellent, although local pollution problems do occur as a result of irrigation practices. Dissolved solids range from 200 to 400 mg/l, but concentrations of 1,250 mg/l have been reported; the water is generally hard; fluorides are usually less than 0.9 mg/l; but nitrate nitrogen has often exceeded 10 mg/l. The effects of irrigation on ground-water quality are varied, but in most places where, prior to irrigation, the water was not highly mineralized and where the water table had shown a significant use, the water quality has deteriorated. Of primary concern from a health standpoint is the high nitrate concentration which exceeds, in some areas, the maximum concentration of 10 mg/l nitrate nitrogen, recommended by the PHS Drinking Water Standards. Nitrate nitrogen concentrations above 10 mg/l can cause "blue babies"--methemoglobinemia, which, in effect, is oxygen starvation of the blood stream.

The mineral quality of ground-water supplies for selected communities is presented in table 30.

Treatment

Table 31 summarizes water treatment practices of communities in the subregion. Mineral removal and specialized treatment are not listed. Treatment of ground water is not extensive, although several large municipalities do provide disinfection. In addition, the City of Quincy provides splash trays to remove excess amounts of gas found in the well water and Coulee Dam provides zeolite pressure filters for hardness removal. Nearly all municipalities utilizing surface or mixed sources provide at

Table 30 - Mineral Water Quality of Ground-Water Supplies, Subregion 2

	SiO_2	Fe	Ca	Mg	Na	HCO_3	SO_4	Cl	NO_3-N	Total Solids	Hard. $CaCO_3$	F	pH
	mg/1												
Okanogan, Wn. 3/27/58	19	0.44	54	23	34	227	109	3.0	0.7	360	229	0.5	7.8
Omak, Wn. 10/21/59	28	0.19	55	29	13	244	75	1.8	1.6	329	256	0.5	8.0
Oroville, Wn. 10/20/59	22	0.02	65	16	27	254	67	3.5	4.8	335	228	0.3	7.7
Cashmere, Wn. 5/11/61	22	0.00	48	21	16	276	10	4.5	3.1	263	208	0.2	7.2
East Wenatchee W. D., Wn. 10/20/59	29	0.02	49	11	14	199	14	3.8	16.0	238	168	0.2	7.6
Waterville, Wn. 10/20/59	43	1.6	46	23	23	204	35	26.0	18.0	316	209	0.3	7.7
Republic, Wn. 4/7/60	29	0.02	46	8.6	14	130	65	4.2	3.8	238	150	0.3	7.0
Ephrata, Wn. 10/19/60	55	0.03	24	10	15	147	10	4.3	1.4	202	109	0.3	7.5
Connell, Wn. (Well #3) 10/17/60	48	0.56	26	12	18	138	22	10.0	8.8	219	112	0.5	7.9
Othello, Wn. (Well #3) 5/4/61	62	0.00	3	0.8	81	170	27	14.0	0.0	293	10	2.8	8.6
Ritzville, Wn. (Well #3) 10/22/59	43	0.01	63	36	23	238	42	56.0	47.0	433	304	0.2	8.2
Moses Lake, Wn. (Well #7) 12/4/59	60	0.02	8	2.1	64	155	19	17.0	0.9	264	29	2.5	8.3

Table 31 - Summary of Municipal Water Sources and Treatment Practices, Subregion 2

Source	Number of Municipal Facilities	Population Served Thousands	Percent of Total Population
Ground			
No treatment	37	54.6	32.0
Disinfection	9	37.7	22.1
Complete	1	0.3	0.2
	47	92.6	54.3
Surface			
No treatment	1	0.3	0.2
Disinfection	8	15.3	9.0
Complete	2	34.0	19.9
	11	49.6	29.1
Mixed			
No treatment	0	0.0	0.0
Disinfection	4	4.4	2.6
Complete	1	24.0	14.0
	5	28.4	16.6
Total	63	170.6	100.0

least disinfection, and three large communities withdrawing from the Columbia River have complete treatment.

Municipal

Approximately 68 percent of the population, or 170,600 persons, are served by municipal water systems. The principal water-use center is the Tri-Cities Service Area. The municipal water requirement for this service area is 14.8 mgd, or 35 percent of the subregion's total municipal demand. Major municipal water requirements also exist in the Wenatchee and Moses Lake areas, which use 5.2 and 3.0 mgd.

Ground water is utilized extensively for municipal water supplies in the subregion. About 54 percent of the municipal water requirement is satisfied by ground-water sources. In addition, approximately 17 percent of the water demand is supplied from mixed sources of ground and surface water. Withdrawals from surface sources account for the remaining 29 percent of the municipal water requirement.

The most abundant supply of ground water available is in the Crab Creek drainage in the southern plateau area, where yields of over 500 gpm are commonplace. The communities in and around the drainage, including Quincy, Ephrata, Soap Lake, Moses Lake, Othello, Odessa, and Warden rely almost entirely upon this source. The Columbia Basin Irrigation Project has greatly increased the amount of ground water in this area, and there are now several places where the water table is within 30 feet of the surface. Yields are smaller in the remainder of the subregion south of the Columbia River and the lower Spokane River Valley but are generally greater than 50 gpm. Most communities in this area use ground-water sources, but several need improved sources. In the Colville, Sanpoil, Okanogan, and Methow River valleys, alluvial deposits yielding moderate to large quantities of water are used for municipal supplies. However, several communities in these valleys need improved sources.

The only extensive use of surface waters for municipal purposes is along the main stem of the Columbia River and in the Wenatchee and Chelan River drainages. Municipalities withdrawing water from the Columbia River are Coulee Dam East and West, Grand Coulee, Kettle Falls, Wenatchee, Pasco, and Richland. The cities of Pasco, Richland, and Wenatchee provide complete treatment before distribution, and the other cities provide disinfection. In general, there are adequate quantities of good quality surface water in most areas. The Okanogan River drainage has the only critical shortage of surface water. However, this does not

significantly affect municipal water supplies since there are large quantities of ground water.

Industrial

The industrial water demand, exclusive of the Hanford Atomic Works, is about 46.8 mgd. Of this total, about 22.7 mgd are from surface sources, and 24.1 mgd are from ground-water sources. The principal industrial water users in the subregion are the primary metals, food products, and wood and lumber products industries. These industries require 17.6, 12.0, and 12.8 mgd, respectively.

The primary metals industry is the largest industrial water user in the subregion. About 3.0 mgd for cooling purposes and 13.0 mgd for process waters are withdrawn from the Columbia River.

The water demand for the food products industry is centered in the Wenatchee, Okanogan, and Chelan areas for fruit processing, and in the Moses Lake area for potato processing and sugar refining. The water demand for fruit processing is largely for fruit washing and cooling of cold storage warehouses. Only a small portion of the 3.9 mgd water requirement is needed for the remainder of the processing. The potato-processing and sugar-refining industries have water needs of about 5.0 and 3.2 mgd, respectively. Ground-water supplies are used almost exclusively by the food processing industries.

There are numerous sawmill and lumber operations in the northern and northwestern portions of the subregion. However, only a few of these have a significant water demand. These lumber operations need 9.5 mgd. The combined total use for other lumber mills is 3.3 mgd. In general, surface-water sources are utilized. At Omak, ground water is used, since flows in the Okanogan River are greatly depleted during the summer months.

The mining industry in the northern mountainous area of the subregion has a water requirement of about 1.3 mgd. Water is withdrawn primarily from surface sources.

There is no significant industrial water use in the Tri-Cities Service Area. The Hanford Atomic Works near the service area has a large water requirement for cooling and other purposes, but data as to its magnitude are not available.

Rural-Domestic

Approximately 79,620 persons, or 32 percent of the subregion's population, are served by individual water systems. This portion of the population has a water demand of about 10.0 mgd. The livestock population has a water requirement of about 6.0 mgd.

In general, the quality and quantity of both surface and ground waters in the subregion are adequate for rural-domestic purposes. However, there is a shortage of surface-water supplies in the Okanogan River drainage as a result of irrigation diversions. Also, an important water quality problem exists in some ground waters of the Crab Creek drainage as previously mentioned.

FUTURE NEEDS AND MEANS TO SATISFY NEEDS

The principal factors that will determine future water needs in the Upper Columbia Subregion are population growth and industrial expansion, particularly for food processing. As these increase, the need for water will also increase.

Based on the projected economic development of Subregion 2, the population is expected to increase from 250,200 in 1965 to 548,000 in 2020. This represents an increase of 119 percent for the subregion, as compared with 121 percent for the region. Table 32 shows the projected population for municipal and rural categories.

Table 32 - Projected Population, Subregion 2

	1980	2000	2020
	Thousands		
Tri-Cities Service Area	103.7	156.1	213.5
Municipal	103.7	156.1	213.5
Rural	--	--	--
Other	218.8	274.7	334.5
Municipal	148.4	199.6	254.0
Rural	70.4	75.1	80.5
Total Subregion	322.5	430.8	548.0
Municipal	252.1	355.7	467.5
Rural	70.4	75.1	80.5

Production growth of the major industries is projected to substantially increase by 2020. It is anticipated that food and kindred products and primary metals will continue to be the major water-using industries.

Municipal

Basis for Water Supply Projections

The projected population to be served by municipal water systems, as shown in table 32, indicates that by the year 2020, approximately 85 percent of the population will obtain water from central distribution systems. The entire population of the service area is expected to be served by central distribution systems by that time.

The subregion is in Climatic Designation 2, as defined in the "Future Needs" section of the Regional Summary for determination of projected municipal per capita water consumption. The average requirement is expected to be 275 gpcd by 1980, 295 gpcd by 2000, and 310 gpcd by 2020.

Projections of Water Supply Requirements

The anticipated municipal water requirements for the years 1970, 1980, 2000, and 2020 are presented in table 33. The present water use is expected to increase to 145 mgd by 2020. By 2020, municipal requirements will account for approximately 47 percent of the total subregional needs. The Tri-Cities Service Area is expected to require nearly 45 percent of the municipal demand by the end of the projection period.

Table 33 - Projected Municipal Water Use, Subregion 2

	1970	1980	2000	2020
	MGD			
Tri-Cities Service Area	22.5	28.5	46.0	66.2
Other	26.5	33.7	52.6	79.0
Total	49.0	62.2	98.6	145.2

Problems and Solutions

There is no subregion-wide shortage of water for present and projected requirements; however, localized supply difficulties are certain to emerge. Ground water is utilized extensively for municipal water supplies in the subregion. The Columbia Basin Irrigation Project has greatly increased the amount of ground water in this area, and there are several places where the ground-water table is within 30 feet of the surface. The quality is generally adequate for all municipal purposes with minimal treatment; however, increased pumping, coupled with poor land and water-use practices, tends to deteriorate the quality of the ground water.

Ground waters in the vicinity of Moses Lake contain concentrations of nitrate nitrogen greater than the limits (10 mg/l as nitrogen) recommended by the Public Health Service Drinking Water Standards. Higher levels of treatment will be required as water needs increase and as the quality of the ground water deteriorates. The quality of the ground water can be controlled to some degree by improving irrigation practices.

The only extensive use of surface supplies for municipal purposes in the subregion is along the main stem of the Columbia River and in the Wenatchee and Chelan River drainages. In general, there are adequate quantities of good quality surface waters in most areas of the subregion.

Industrial

Basis for Water Supply Projections

Projected industrial water use, as previously mentioned, is the product of a growth index and present water use. The forecast growth indices for the major water-use categories are shown in table 34 for the years 1980, 2000, and 2020, with 1963 as the base year. The indices were derived from data presented in Appendix VI.

Table 34 - Industrial Growth Indices, Subregion 2

	1980	2000	2020
		(Base Year 1963 = 1.00)	
Primary metals	1.37	1.67	1.97
Food products	1.60	2.50	3.75
Pulp and paper	2.67	4.33	6.67
Lumber and wood products	1.36	1.55	1.63

Projections of Water Supply Requirements

Projected water needs by major industrial categories are presented in table 35 for the years 1970, 1980, 2000, and 2020. By 2020, industrial needs will be about 144 mgd, or 44 percent of the total water needs in the subregion.

Table 35 - Projected Industrial Water Use, Subregion 2

	1970	1980	2000	2020
	MGD			
Pulp and paper	5.0	6.4	10.4	16.0
Food products	19.5	30.4	48.1	73.0
Primary metals	18.8	24.2	29.4	34.6
Lumber and wood products	13.5	17.4	19.8	20.9
Total	56.8	78.4	107.7	144.5

The food products and primary metals industries will continue to be the major water users, requiring approximately 73 and 35 mgd, respectively, by 2020. The pulp and paper industry will expand significantly in the Wenatchee area but will remain a relatively minor water user. The lumber and wood products industry will continue to expand at a declining rate.

Problems and Solutions

Water demands for the food products industry are highly seasonal; but no significant problems are expected because groundwater supplies are used almost exclusively.

Rural-Domestic

Basis for Water Supply Projections

The population expected to rely on individual water systems is shown in table 32. The projections show that about 15 percent of the population will be served by individual systems by 2020.

Based on assumptions presented in the "Future Needs" section of the Regional Summary, the expected per capita water consumption for the rural population will be 165 gallons per day in 1980, 205 in 2000, and 250 in 2020.

The projected livestock population is based on data presented in Appendix VI. It has been assumed for purposes of this study that the water use per animal will remain constant during the projection period.

Projections of Water Supply Requirements

The anticipated rural-domestic water requirements are presented for the years 1970, 1980, 2000, and 2020 in table 36. The rural-domestic needs are forecast to increase to about 38 mgd by 2020; of this amount, approximately 20 mgd will be required for domestic purposes and 18 mgd for livestock watering.

Problems and Solutions

Rural-domestic requirements are scattered throughout the subregion. Ground-water supplies are generally adequate to satisfy existing and projected needs. In certain areas, however, localized problems exist. High nitrate concentrations are encountered in the Moses Lake area, and many shallow supplies are not properly protected against bacterial contamination. In general, the problems can be best corrected on an individual basis.

Table 36 - Projected Rural-Domestic Water Use, Subregion 2

	1970	1980	2000	2020
	MGD			
Domestic	10.7	11.6	15.4	20.1
Livestock	8.0	10.3	13.6	17.9
Total	18.7	21.9	29.0	38.0

LOCATION MAP

SUBREGION 3

S U B R E G I O N 3

Y A K I M A

INTRODUCTION

Subregion 3 consists of the area drained by the Yakima River and lies entirely within the State of Washington. The total area is 6,062 square miles. The principal tributaries of the Yakima River drain the eastern slopes of the Cascade Range. About three-fourths of the subregion is in the Columbia Basin physiographic province. The remainder is in the Cascade Range.

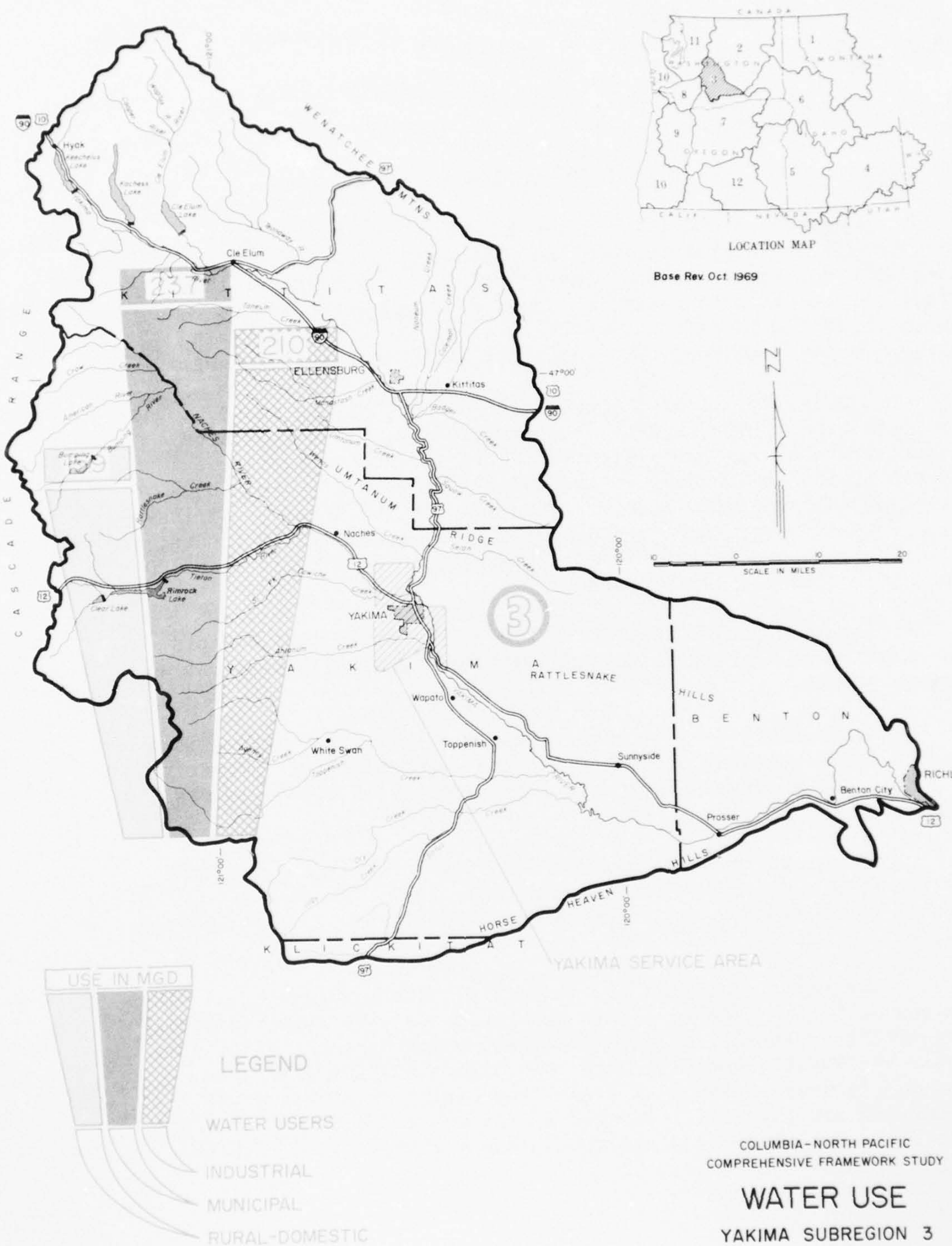
Similar to all of the area east of the Cascade Range, total precipitation is low, and the temperature range is quite large. Record temperatures range from -25°F. to 110°F. A frost-free season of 160 to 200 days in the valleys is normal. About one-third of the subregion receives less than 10 inches of precipitation annually; the remaining area receives from 10 to 30 inches, although in a small area of the Cascades a total of more than 100 inches is consistently recorded.

The mean annual runoff for the Yakima River is 3,240 cfs. The high runoff occurs in May and June, and generally drops to a low in August.

Agriculture is the primary economic activity. Yakima is a center for processing of both fruit and vegetable crops grown in the adjacent valleys. There are a few lumber and wood products plants.

In the valleys, population densities are high, but in the surrounding rangelands they are extremely low. The population totals about 184,500 and is centered in the towns along the Yakima River.

The major municipal and industrial water-use centers in the Yakima Subregion (figure 4) are the Yakima Service Area, including the cities of Yakima, Selah, Moxee, and Union Gap; the Ellensburg area; the Wapato-Toppenish area; the Grandview-Sunnyside area; and the Prosser-Benton City area. The cities of Richland and Kennewick are physically located in the Yakima Subregion, but are not discussed since they are more closely interrelated with the Upper Columbia Subregion.



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

WATER USE

YAKIMA SUBREGION 3

1970

FIGURE 4

PRESENT STATUS

The municipal major industrial, and rural-domestic water needs for the Yakima Service Area and the remainder of the subregion are summarized in table 37. At present, the water requirement averages about 60.6 mgd, including a municipal water demand of 23.7 mgd, an industrial demand of 21.0 mgd, and a rural-domestic demand of 15.9 mgd.

Table 37 - Present Municipal, Major Industrial, and Rural-Domestic Water Supply Needs, Subregion 3

	Municipal	Industrial	Rural-Domestic	Total	% Total Basin
	MGD				
Yakima Service Area	12.5	10.2	3.8	26.5	43.7
Other	11.2	10.8	12.1	34.1	56.3
Total	23.7	21.0	15.9	60.6	100.0

Table 38 presents monthly demand data for municipal water use in the subregion and for industrial water use in the principal centers. Since insufficient data are available concerning the monthly municipal pattern in these areas, a satistical analysis of similar areas in the Pacific Northwest was used to derive the

Table 38 - Monthly Variation in Water Needs, Subregion 3

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	Percent											
Municipal	67	70	71	86	90	143	186	145	121	81	72	66
Industrial												
Yakima Service Area												
Food processing	59	61	71	64	60	74	79	88	276	216	164	65
Lumber and wood products	100	100	100	100	100	100	100	100	100	100	100	100
Ellensburg area												
Food processing	70	73	72	81	129	134	91	79	218	145	73	70
Wapato-Toppenish area												
Food processing	178	178	5	13	21	25	13	26	198	195	178	178
Grandview-Sunnyside area												
Food processing	90	91	84	80	76	96	94	98	109	151	135	85
Prosser-Benton area												
Food processing	16	32	23	26	51	73	89	152	194	195	250	21

figures. Municipal water needs are greatest from June through September. The maximum monthly requirement during this period is generally 120 to 186 percent of the average monthly demand. There is little seasonal variation in the lumber and wood products industry. However, the food-processing industry has a distinct water requirement pattern. The peak water demand occurs in the fall. During this period, the maximum monthly requirement is as much as 275 percent of the average monthly demand.

Water Quality

Surface Water

The quality of surface waters in Subregion 3 is generally undesirable for municipal and industrial water supplies without complete treatment. On the other hand, the headwaters are usually of good quality, and, if treatment needs are based on criteria shown in Table 1, a minimum treatment of disinfection would be required. As noted in the Regional Summary, however, the State of Washington requires that all surface sources of supply be given complete treatment unless adequate protection and water quality control is provided in the tributary watershed. The primary constituents that must be removed or treated before use are color and turbidity, bacteria, and taste- and odor-producing biological growths.

The headwaters of the Yakima River and its tributaries are a very soft calcium bicarbonate water with an average dissolved solids concentration of about 40 mg/l. Intensive downstream irrigation results in an increase in mineralization. At Kiona, the dissolved solids concentration averages 169 mg/l, and the water is moderately hard. The water is still primarily calcium bicarbonate, but the percentages of sulfate and sodium are twice those found in the headwater streams. However, the concentrations of chemical constituents are within the requirements set forth in the PHS Drinking Water Standards throughout the full length of the river. Table 39 shows the quality of surface-water supplies of several communities.

The Yakima River and some tributaries periodically exhibit turbidity and color concentrations which would require treatment of the water for domestic and some industrial uses. These excessive concentrations are most notable during periods of high runoff, although irrigation return flows usually contribute during the irrigation season.

Maximum water temperatures (75° F. or higher) in the lower reaches of the Yakima during the summer months make the water

Table 39 - Summary of Water Quality Data for Surface Water, Subregion 3

	River Mile	D.O. (mg/l)	T (^{o}C)	Coliform MPN/ 100ml	pH	Color (PT-CO) Units	Hard. (mg/l)	Turb. (JTU)	TDS (mg/l)	Ortho PO_4 (mg/l)	NO_3-N (mg/l)
MAIN STEM YAKIMA RIVER											
Yakima River at Cle Elum, Wn.	183.1										
Mean		11.0	8.9	478	7.3	3	24	1	37	0.01	0.03
Min.		8.7	1.0	0	6.8	0	18	0	26	0.00	0.00
Max.		13.5	18.5	9,300	7.9	5	36	5	55	0.12	0.25
Yakima River at Roza Dam											
Mean		9.6	16.7	1,615	7.2	--	--	--	--	0.06	0.18
Min.		8.2	15.2	930	6.3	--	--	--	--	0.05	0.14
Max.		11.8	18.0	2,300	7.8	--	--	--	--	0.06	0.22
Yakima River at Union Gap, Wn.											
Mean		9.0	16.7	60,392	7.6	--	51	--	--	0.15	0.96
Min.		7.6	1.0	230	6.4	--	49	--	--	0.06	0.15
Max.		13.6	21.6	460,000	8.6	--	54	--	--	0.44	4.78
Yakima River at Kiona, Wn.											
Mean		10.6	15.8	5,995	8.1	13	128	10	--	0.07	0.80
Min.		8.2	2.5	100	7.4	5	52	1	--	0.01	0.18
Max.		14.3	26.5	20,000	8.9	22	278	60	--	0.10	1.38
Yakima River at Richland, Wn.											
Mean		--	--	--	--	--	--	--	--	0.05	0.34
Min.		7.3	0	5	7.2	0	44	0.5	--	0.03	0.17
Max.		15.8	27.7	15,000	9.1	30	190	245	--	0.08	0.69
TRIBUTARIES											
Naches River near Naches, Wn.	116.3-17.6										
Mean		11.8	7.9	107	7.3	5	24	4	49	0.03	0.03
Min.		8.9	0.4	0	7.0	0	16	0	31	0.00	0.00
Max.		14.5	19.3	930	7.7	20	36	20	71	0.08	0.09
Naches River near Yakima, Wn.	116.3-0.1										
Mean		11.9	9.6	394	7.5	5	30	6	60	0.05	0.05
Min.		8.5	0.0	0	6.3	0	19	0	37	0.00	0.00
Max.		16.6	22.8	4,600	8.8	15	48	20	87	0.10	0.20
Tieton River at Oak Creek, Wn.	116.3-17.5-1.6										
Mean		11.3	8.5	74	7.4	7	31	15	62	0.05	0.05
Min.		8.5	0.3	0	7.1	0	22	5	44	0.00	0.00
Max.		14.0	19.0	430	7.9	25	43	120	88	0.25	0.11
Wilson Creek at Thrall, Wn.	147.0-0.4										
Mean		10.0	7.6	2,346	7.5	6	136	--	221	--	0.77
Min.		8.9	4.1	230	7.3	5	86	--	143	--	0.34
Max.		11.7	12.9	11,000	7.8	10	158	--	260	--	1.38
Teanaway River near Cle Elum, Wn.	176.1-0.1										
Mean		11.3	8.5	1,922	7.7	5	61	7	80	0.02	0.07
Min.		8.5	0.5	0	7.2	0	42	0	58	0.00	0.00
Max.		15.1	21.0	23,000	8.6	15	94	60	119	0.07	0.27

undesirable for domestic and industrial use. Heavy algal growths in this portion of the river also impart objectionable taste and odor problems to the water.

A minimum treatment of chlorination would be needed for all surface waters, and the major portion of the Yakima River would require complete treatment before distribution. The bacterial quality of the Yakima River below Ellensburg is above recommended limits for a raw water supply for municipal and food-processing purposes.

Ground Water

In general, the quality of ground water in the subregion is adequate for most municipal and industrial purposes. However, there are several localized areas in the subregion where treatment (in addition to chlorination) is required to make the water a suitable supply. Wells from 500 to 1,000 feet deep in the Yakima Valley are consistently plagued by serious iron bacteria problems.

The mineral quality of ground-water supplies for selected communities is listed in table 40. The mineral content of ground water is generally higher than that of surface water but is less than 500 mg/l (recommended standard) in nearly all cases. The waters are generally a calcium-magnesium bicarbonate type, and the total hardness of most wells is less than 150 mg/l. Wells in the Ellensburg formation, however, are characterized by moderately hard to hard waters. In some localized areas the hardness of the water is high enough to justify softening.

Table 40 - Mineral Water Quality of Ground-Water Supplies, Subregion 3

	SiO_2	Fe	Ca	Mg	Na	HCO_3	SO_4	Cl	NO_3	Total Solids	Hard. $CaCO_3$	F	pH
	MG/L												
Prosser, Wn. (Well #4) 5/11/61	46	0.06	16	6.6	46	202	0.6	9.5	0.1	236	67	0.7	7.8
Ellensburg, Wn. 3/14/57	58	0.74	18	9.2	8.6	120	1.3	2.0	0.8	159	83	0.2	7.4
Toppenish, Wn. (Well #6) 10/19/59	68	0.08	13	2.2	19	105	0.3	1.0	0.2	160	42	0.6	7.8
Selah, Wn.	57	0.00	84	31.0	58.0	459	60.0	13.0	7.0	559	338	0.6	7.9

Some wells in the basalt aquifers reportedly contain small amounts of hydrogen sulfide. Several communities have treatment problems resulting from objectionable quantities of hydrogen sulfide and/or methane gas. A slime-like growth, at least partly attributable to the gas, has also been found in some well

supplies. In addition, bacterial contamination of shallow wells in some suburbs of Yakima has been reported by the Yakima County Health Department.

Generally, the quality of ground water is adequate for the majority of the subregion's industrial uses, such as cooling or washing. However, ground water to be used in all but low pressure boilers must be softened and the silica content reduced to prevent excessive scaling.

Treatment

A summary of water treatment practices in Subregion 3 is presented in table 41. Mineral removal and specialized treatment are not listed. Disinfection of ground water is not extensive, with over one-half of the communities having no chlorination facilities. Several municipalities must provide aeration equipment to remove excessive amounts of gas found in well waters, particularly hydrogen sulfide and methane. Communities relying on mixed or surface supplies now provide at least chlorination

Table 41 - Summary of Municipal Water Sources and Treatment Practices, Subregion 3

Source	Number of Municipal Facilities	Population Served Thousands	Percent of Total Population
Surface			
No treatment	1	0.3	0.3
Disinfection	1	1.9	2.1
Complete	-	-	-
	2	2.2	2.4
Ground			
No treatment	11	18.2	19.6
Disinfection	7	27.5	29.6
Complete	-	-	-
	18	45.7	49.2
Mixed			
No treatment	-	-	-
Disinfection	2	45.0	48.4
Complete	-	-	-
	2	45.0	48.4
Total	22	92.9	100.0

before distribution. Generally, only municipalities in the headwater areas utilize surface waters.

Municipal

Approximately 50 percent of the population in the subregion, or 92,890 persons, are served by municipal water systems. This portion of the population has an average annual water need of about 23.7 mgd. The distribution of this requirement shows that use is concentrated in the Yakima Service Area, which accounts for 53 percent of the total municipal demand.

Ground water is utilized extensively for municipal water supplies. Of the 22 municipal systems, 18 rely solely upon underground sources, and two others use mixed sources of ground and surface waters. Approximately 70 percent of the municipal water used is from ground-water sources.

The Yakima Service Area, which includes the cities of Yakima, Selah, Moxee City, and Union Gap, has a municipal water need of 12.5 mgd. Most of this requirement is for the City of Yakima, which presently obtains its water supply mainly from infiltration galleries along the Naches River and supplements the supply with wells during periods of high demand and low flow. Yakima has a new 20 mgd filter plant ready for operation on the Naches. The infiltration system will be abandoned as soon as the plant is totally in operation. All other communities in this area utilize ground water.

Outside of the Yakima Service Area, the major municipal water use is in the Ellensburg, Wapato-Toppenish, Grandview-Sunnyside, and Prosser-Benton City areas. These urban areas account for three-fourths of the municipal requirement, exclusive of that used by Yakima, or approximately 2.4, 2.3, 2.6, and 1.1 mgd, respectively. The remainder of the municipal demand of 2.8 mgd is scattered throughout the subregion. With the exceptions of Cle Elum, Roslyn, and Easton, all communities depend upon ground-water sources.

Industrial

The industrial water requirement is about 21.0 mgd. Most of this demand is withdrawn from ground-water sources. The principal industrial water users are the food-processing and the lumber and wood products industries, which require 12.8 and 8.2 mgd, respectively.

The water need for the food-processing industry is centered in the Yakima, Ellensburg, Wapato-Toppenish, Grandview-Sunnyside, and Prosser-Benton City urban areas. This need is highly seasonal, ranging from a maximum of about 26 mgd in September to a minimum of 6 mgd during March. Major water-using lumber and wood products firms are located at Yakima and Naches. Little seasonal variation is shown for this water requirement.

In the Yakima Service Area the annual industrial water need averages about 10.2 mgd, including 3.2 mgd for food processing and 7.0 mgd for lumber and wood products. The peak water requirement is approximately 15.3 mgd during September as a result of the seasonal nature of the food-processing industry. The lumber industry is the largest individual water user, with an average requirement of 7.0 mgd. The food-processing industry has an average demand of 1.7 mgd. In general, the industries in the area obtain water from the municipal system or from individual wells.

The food-processing industry in the Ellensburg area relies almost entirely upon the municipal facilities as a source of water. The average water requirement is about 1.0 mgd, but ranges to a maximum of 2.2 mgd during September.

In the Wapato-Toppenish area, water use for industrial purposes is about 4.4 mgd, of which 3.3 mgd are used for sugar refining, and the remaining 1.1 mgd for meat packing and other types of food processing. The maximum industrial requirement occurs from September to February (8.7 mgd) and falls to less than 1.0 mgd during the remainder of the year. Most of the industries in the area depend upon independently developed groundwater supplies.

In the Grandview-Sunnyside and Prosser-Benton City areas, the industrial water requirements are 1.8 and 2.1 mgd, respectively. Food processing, as in most other areas, constitutes the major water use. However, the maximum water need in these areas occurs in October and November. During this peak period the water demands for the Grandview-Sunnyside and Prosser-Benton City areas are approximately 2.7 and 5.3 mgd, respectively.

Other industrial water use is limited to small food-processing firms scattered throughout the area and several lumber mills, which have a total average water requirement of about 1.2 mgd.

Rural-Domestic

Approximately 91,610 persons, or 49.7 percent of the subregion's population, are served by individual water systems. This portion of the population has an average water need of about 11.5 mgd. The livestock population has an additional water requirement of about 4.4 mgd.

Ground water is extensively used for rural-domestic purposes in the subregion. In general, surface waters are utilized only in the headwater areas of the Yakima and its tributaries, because most surface waters in the lower portion of the subregion would require treatment before consumption by humans.

FUTURE NEEDS AND MEANS TO SATISFY NEEDS

Population growth and industrial expansion are the major factors that will determine the future water needs of the Yakima Subregion. Food processing will continue to be the major water-using industry and is expected to expand significantly.

The estimated 1965 population of 184,500 in the subregion is projected to increase 77 percent to 327,000 by 2020. Table 42 shows the projected population for municipal and rural categories for the years 1980, 2000, and 2020. Nearly two-thirds of the population will be centered in the Yakima Service Area by 2020.

Municipal

Basis for Water Supply Projections

The projection in table 42 indicates that by the year 2020, approximately 84 percent of the population will obtain water from central systems. It is expected that the entire population of the Yakima Service Area will be served by a central system by that time.

The Yakima Subregion is in Climatic Designation 2, as defined in the "Future Needs" section of the Regional Summary for determination of projected municipal per capita water consumption. The average requirement is expected to be 275 gpcd by 1980, 295 gpcd by 2000, and 310 gpcd by 2020.

Table 42 - Projected Population, Subregion 3

	1980	2000	2020
	Thousands		
Yakima Service Area	101.0	149.1	213.0
Municipal	81.0	139.1	213.0
Rural	20.0	10.0	-
Other	110.2	109.3	114.0
Municipal	49.1	51.0	60.0
Rural	61.1	58.0	54.0
Total Subregion	211.2	258.4	327.0
Municipal	130.1	190.4	273.0
Rural	81.1	68.0	54.0

Projections of Water Supply Requirements

The anticipated municipal water requirements for the years 1970, 1980, 2000, and 2020, are presented in table 43. The present water use is forecast to increase to 81.9 mgd by 2020. At that time, municipal requirements will account for approximately 50 percent of the total subregional needs. The Yakima Service Area is expected to require nearly 78 percent of the municipal need by the end of the projection period.

Table 43 - Projected Municipal Water Use, Subregion 3

	1970	1980	2000	2020
	MGD			
Yakima Service Area	16.7	25.0	41.0	62.9
Other	12.0	13.7	18.1	19.0
Total	28.7	38.7	59.1	81.9

Problems and Solutions

Ground water is expected to be utilized extensively for municipal water supplies in the subregion. Except for the headwaters, the quality of surface waters is generally undesirable for municipal water supplies without complete treatment. Intensive downstream irrigation results in an increase in mineralization and higher bacterial counts.

As the needs increase, some of the well fields may experience pumping difficulties, and the quality may deteriorate. The problem in most cases can be avoided by optimum spacing of wells and modification of the pumping schedules. On rare occasions it will be necessary to resort to reliance on surface waters to meet the increased requirements.

Industrial

Basis for Water Supply Projections

Projections of industrial water use were developed primarily by application of growth factors to the present water use. The predicted growth indices for the major water-use categories are shown in table 44 for the years 1980, 2000, and 2020. The indices were derived from data presented in Appendix VI.

Table 44 - Industrial Growth Indices, Subregion 3

	1980	2000	2020
	(Base Year 1963 = 1.00)		
Food products	1.55	2.25	3.22
Lumber and wood products	1.39	1.69	1.85

Projections of Water Supply Requirements

Projected water needs by major industrial categories are presented in table 45 for the years 1970, 1980, 2000, and 2020. By 2020, industrial needs will be about 58.6 mgd, or 34 percent of the total water needs in the subregion.

In general, the increases in water use have been projected to occur at existing locations. Although industries will

undoubtedly locate in other new areas, locational shifts were not projected in the analyses.

Table 45 - Projected Industrial Water Use, Subregion 3

	1970	1980	2000	2020
	MGD			
Food products	15.4	20.8	30.2	43.4
Lumber and wood products	11.0	11.4	13.9	15.2
Total	26.4	32.2	44.1	58.6

The food-processing industry will be the largest water user, requiring 43 mgd by 2020. The lumber and wood products industry is projected to increase at a slower rate.

Problems and Solutions

Most of the industrial water supply is withdrawn from groundwater sources. No major problems are expected in the subregion during the projection period. Localized problems may occur from over-pumping to satisfy the seasonal demand for the food-processing industries. The spacing of wells and modification of pumping schedules will, in most cases, correct the problems.

Rural-Domestic

Basis for Water Supply Projections

The projected population which will rely on individual systems is shown in table 42. The projections show that only about 16 percent of the population will be served by individual systems by 2020.

Based on assumptions presented in the "Future Needs" section of the Regional Summary, the expected per capita water consumption for the rural population will be 165 gallons per day in 1980, 205 in 2000, and 250 in 2020.

The projected livestock population is based on data presented in Appendix VI. It has been assumed, for purposes of this

study, that the livestock water use per animal will remain constant during the project period.

Projections of Water Supply Requirements

The anticipated rural-domestic water requirements for the years 1970, 1980, 2000, and 2020 are presented in table 46. The rural-domestic demand is forecast to increase to about 27 mgd by 2020, of which approximately 13.4 mgd will be required for domestic purposes and 13.6 mgd for livestock watering.

Table 46 - Projected Rural-Domestic Water Use, Subregion 3

	1970	1980	2000	2020
	MGD			
Domestic	11.6	13.4	13.9	13.4
Livestock	6.3	7.8	10.5	13.6
Total	17.9	21.2	24.4	27.0

Problems and Solutions

Rural-domestic requirements are scattered throughout the subregion. Ground-water supplies are extensively used and are adequate to satisfy the existing and projected needs. Most supplies are from shallow aquifers, and bacterial contamination is an increasing problem. For the most part, the problems encountered with individual water supplies can be corrected on an individual basis.

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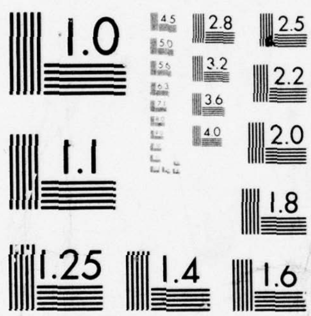

MICROCOPY RESOLUTION TEST CHART
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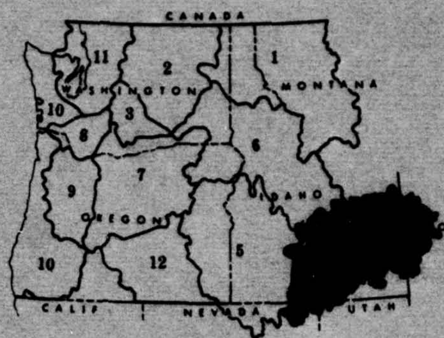


LOCATION MAP

SUBREGION 4

UPPER SNAKE

INTRODUCTION

Subregion 4 drains an area of 35,857 square miles in Idaho, Wyoming, Nevada, and Utah. The Snake River is the dominant stream traversing the subregion from east to west. From its headwaters in Yellowstone National Park, the river flows some 500 miles, skirting the Snake River Plain on the south before it leaves the subregion on the west. The major tributaries generally are in the southern and eastern portions of the subregion. A large area north of the Snake River is drained by streams which sink into the lava fields. The extensive aquifer beneath the Snake River Plain is a distinguishing hydrologic feature.

The climate varies throughout the subregion because of its size and wide range in elevations. The climate is characterized by cold winters, during which most of the precipitation falls, and by warm-to-hot, dry summers. Extreme temperatures recorded range from -60°F. to 110°F. The average growing season on the Snake River Plain ranges from 140 to 150 days at the lower end of the plain to about 100 days at the upper end. The average annual precipitation ranges from 10 to 40 inches.

The streamflow distribution is modified by storage regulation which outweighs natural influences in determining the pattern of discharge. There is at least one dam on most of the streams, and there are also dams across the outlets of several natural lakes. In dry years, the total flow of the Snake River is allotted to present users; as a result, in these years almost no water passes Milner Dam. However, ground-water contribution from the Snake Plain aquifer at Thousand Springs and throughout the reach below Milner augments the flow before the river leaves the subregion.

Agriculture and food processing are the primary economic activities. There are nearly two and a half million acres of irrigated land. The principal crops grown and processed are potatoes and sugar beets. The National Reactor Testing Station is also an important economic factor. The phosphate industry in southeastern Idaho is the center of western phosphate resources and production. Recreation and tourism are important segments of the economy. Grand Teton National Park, a portion of Yellowstone National Park, Craters of the Moon National Monument, and

several national forests are significant attractions. In addition, the subregion also contains two of the Nation's best winter sport areas--Jackson Hole and Sun Valley.

Total population of the subregion is about 302,000 people. About 49 percent reside in the four major service areas. The population density in the remainder of the area is low--often less than one person per square mile in large areas.

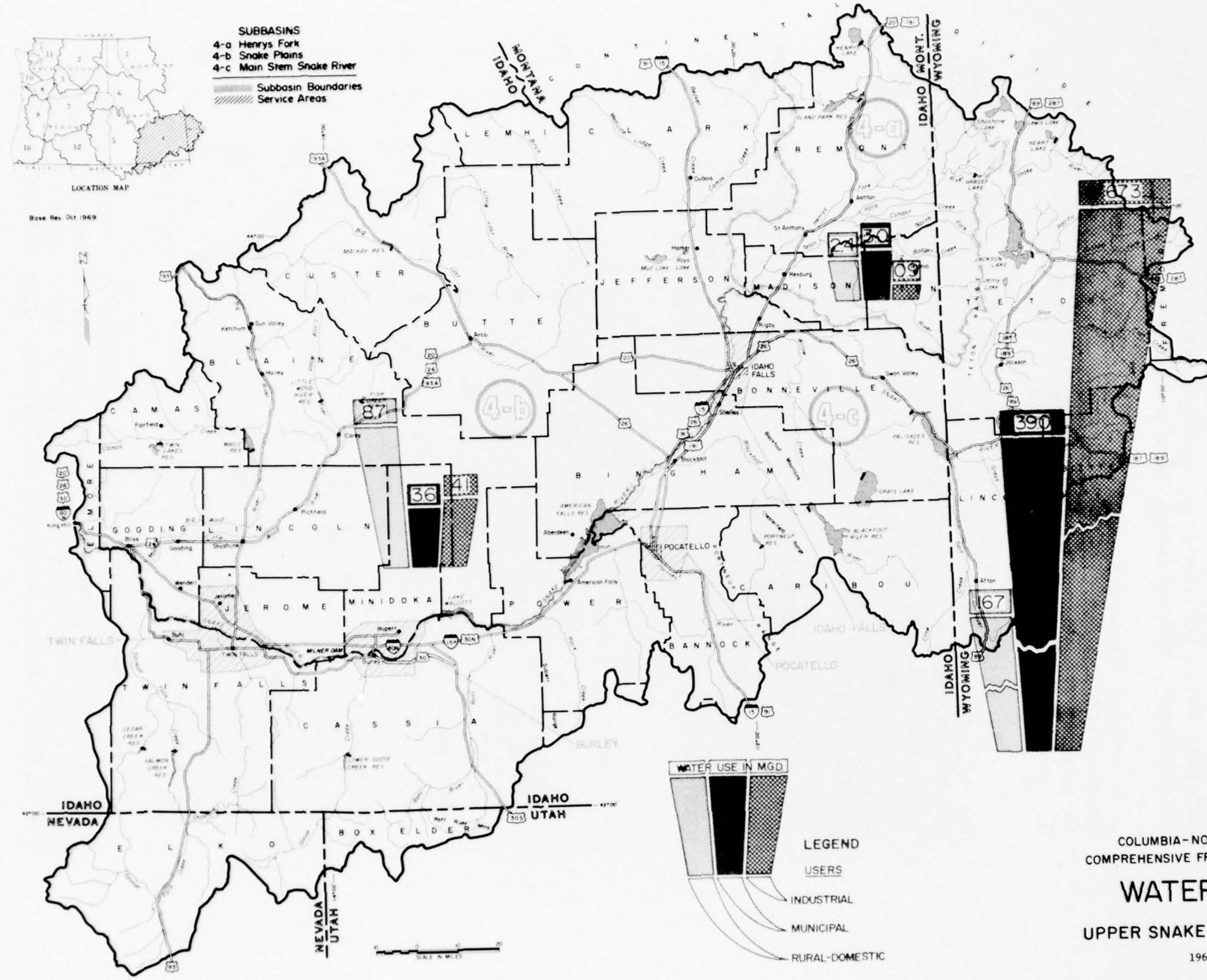
The Upper Snake Subregion (figure 5) is divided into the Henrys Fork, Snake Plain, and Main Stem Snake Subbasins. Figure 5 also shows the water use by subbasin. The major service areas are the Idaho Falls, Pocatello, Burley, and Twin Falls areas.

PRESENT STATUS

Table 47 is a summary of present municipal, major industrial, and rural-domestic water currently required. At present, the water requirement averages about 145.7 mgd, including a municipal demand of 45.6 mgd, an industrial demand of 72.3 mgd, and a rural-

Table 47 - Present Municipal, Major Industrial, and Rural-Domestic Water Supply Needs, Subregion 4

	Municipal	Industrial	Rural-Domestic	Total	% Total Subregion
	MGD				
Henrys Fork Subbasin	3.0	0.9	2.4	6.3	4.3
Main Stem Snake Subbasin					
Idaho Falls Service Area	9.8	8.7	1.7	20.2	13.9
Pocatello Service Area	10.2	38.1	0.7	49.0	33.6
Burley Service Area	3.4	8.2	0.7	12.3	8.4
Twin Falls Service Area	8.3	9.8	0.6	18.7	12.8
Other	7.3	2.5	13.0	22.8	15.7
	39.0	67.3	16.7	123.0	84.4
Snake Plain Subbasin	3.6	4.1	8.7	16.4	11.3
Total	45.6	72.3	27.8	145.7	100.0



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WATER USE

UPPER SNAKE SUBREGION 4

1969

FIGURE 5

domestic demand of 27.8. This demand is generally concentrated in the major service areas. The Idaho Falls, Pocatello, Burley, and Twin Falls Service Areas require about 13.9, 33.6, 8.4, and 12.8 percent, respectively, of the subregion's average water need.

About 60 percent of the population is served by municipal water systems. Approximately 65.5 percent of the systems depend on ground-water sources, 33.6 percent on mixed supplies, and only 0.9 percent on surface-water sources.

The principal industrial water use is for phosphate processing, which requires about 37 mgd or 51 percent of the total industrial demand. Other significant industrial water uses are for sugar refining, potato processing, and milk products. These industries require 14.2, 9.9, and 6.5 mgd, respectively. The National Reactor Testing Station in the Snake Plain Subbasin requires 4.1 mgd.

Table 48 summarizes monthly variation in water demand for major water-use categories in each of the service areas. Since no data concerning the municipal monthly pattern are available, a statistical analysis of water supply distribution for similar areas in the Pacific Northwest was used to derive the figures.

Table 48 - Monthly Variation in Water Needs, Subregion 4

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
							Percent					
Idaho Falls Service Area												
Municipal	67	70	71	86	90	143	186	145	121	81	72	66
Sugar refining	169	169	169	51	0	0	0	0	135	169	169	169
Potato processing	132	132	125	125	104	0	0	42	125	139	139	139
Meat products	101	76	93	101	101	101	101	101	109	109	101	109
Milk products	95	89	101	107	118	118	112	107	95	89	83	89
Pocatello Service Area												
Municipal	67	70	71	86	90	143	186	145	121	81	72	66
Phosphate processing	100	100	100	100	100	100	100	100	100	100	100	100
Meat products	104	82	93	99	99	99	99	99	110	110	99	110
Milk products	95	89	101	107	118	118	112	107	95	89	83	89
Burley Service Area												
Municipal	67	70	71	86	90	143	186	145	121	81	72	66
Sugar refining	169	169	169	51	0	0	0	0	135	169	169	169
Potato processing	132	132	125	125	104	0	0	42	125	139	139	139
Milk products	96	87	104	107	118	118	112	107	96	87	84	87
Twin Falls Service Area												
Municipal	67	70	71	86	90	143	186	145	121	81	72	66
Sugar refining	169	169	169	51	0	0	0	0	135	169	169	169
Potato processing	132	132	125	125	104	0	0	42	125	139	139	139
Meat products	104	82	93	99	99	99	99	99	110	110	99	110
Milk products	96	87	104	107	118	118	112	107	96	87	84	87
Canning and freezing	0	0	0	0	0	0	184	555	368	100	0	0

The distribution of the industrial water need is significant in that food-processing activities have a distinct seasonal pattern. Sugar refining occurs in fall, winter, and early spring, with a start around the first of September that builds rapidly to

a December peak and tapers off in April. Potato processing overlaps the sugar season, running from September through May at high levels and, in some cases, continuing into the summer with inshipments or utilization of the early summer crop. Thus, the current pattern of use is one of high summer municipal and domestic use complementing high winter food-processing use, indicating the feasibility of joint municipal-industrial supply systems in many places.

Water Quality

Surface Water

Most surface waters are of satisfactory quality for most municipal and industrial purposes. However, in several tributaries and certain reaches of the main stem of the Snake River, municipal and industrial waste loadings in combination with irrigation diversions and return flows have degraded water quality below levels satisfactory for domestic or industrial purposes. These conditions, as well as the relative abundance of ground water, result in little use of surface water for municipal, major industrial, or rural-domestic water supplies.

The headwaters of most tributaries are relatively dilute (100 mg/l dissolved solids or less) calcium bicarbonate waters. However, dissolved solids and sodium content show marked increases downstream as a result of irrigation use. The dissolved solids content of some streams as they enter the Snake River is as much as seven times greater than that in the headwaters area. The waters of major tributaries entering the Snake River from the north are a calcium-magnesium bicarbonate type, with smaller amounts of sodium, chloride, and sulfate. Their dissolved solids concentration ranges from less than 100 to slightly more than 300 mg/l and averages less than 250 mg/l. Tributaries entering the Snake River from the south are usually more highly mineralized and have larger percentages of sodium, chloride, and sulfate.

The main stem of the Snake River shows downstream changes in chemical quality which reflect both man's use and the effects of waters of different natural quality entering the stream. Between the Idaho-Wyoming border and Buhl, Idaho, the dissolved solids concentration increases from about 175 to over 400 mg/l.

In parts of the Henrys Fork Subbasin, unusually high concentrations of fluoride occur, with more than 4.0 mg/l reported in places. Big Springs Creek, Buffalo River, Warm River, and Falls River contained greater than 2.0 mg/l fluoride in August 1960. Henrys Fork, from Island Park Reservoir to the mouth, contained from 1.4 to 1.8 mg/l.

Dissolved oxygen levels of the Upper Snake River and its tributaries are usually near the saturation level. However, the dissolved oxygen concentrations of the main stem are depressed at two points within the subregion. In summer, the oxygen level of the water behind American Falls Dam drops several mg/l below that of the water entering the reservoir. During the summer of 1967, a diurnal oxygen fluctuation resulted in a fish kill in the reservoir. In winter, flow out of Milner Dam drops to a minimum level, ice cover inhibits reaeration for several months; and with large amounts of organic wastes entering the reservoir, septic conditions have resulted.

The bacterial quality of the Snake River is highly variable. Coliform densities below service areas are high enough that the water is considered unsuitable for municipal and food-processing purposes. Very high bacterial concentrations are found in the Burley and Idaho Falls-Shelley areas.

Ground Water

Four major aquifer units are used for domestic or industrial water supplies in the subregion. These are the alluvial, basaltic volcanic, silicic volcanic, and consolidated and semi-consolidated sedimentary units. The alluvial and basaltic volcanic units yield moderate to large amounts of water and are used extensively for water supplies. The silicic volcanic and sedimentary units yield much smaller volumes of water and do not receive heavy use, except in the Rexburg area. All aquifer units generally yield water which is of excellent quality. The mineral quality of ground-water supplies for selected communities is listed in table 49.

The water of the alluvial aquifer unit has total dissolved solids that rarely exceed 1,000 mg/l and are generally less than 500 mg/l; the water is moderately hard to very hard but in some places may be soft; the sodium concentration is low; the salinity is medium to high; trace constituents are generally absent; and temperatures range from 45 to 55°F.

The water in the basaltic volcanic aquifer unit generally has total dissolved solids of less than 500 mg/l; hardness ranges from 100 to 200 mg/l; the sodium concentration is low; the salinity is low to medium; troublesome concentrations of trace constituents are seldom found; and temperatures range from 48°F. to 60°F.

The silicic volcanic aquifer unit generally has dissolved solids of less than 500 mg/l; the water is soft to moderately hard; fluorides and boron are seldom excessive; and temperatures are generally satisfactory, although some wells are warm.

Table 49 - Mineral Water Quality of Ground-Water Supplies, Subregion 4

	SiO_2	Fe	Ca	Mg	Na	HCO_3	SO_4	Cl	NO_3	Total Solids	Hard. $CaCO_3$	F	pH
	mg/l												
Aberdeen, Idaho	36	0.00	39	13	22	126	40	20	0.0	245	152	0.7	7.7
American Falls, Idaho	44	0.02	130	28	48	186	54	214	1.8	666	440	0.0	7.8
Arco, Idaho	22	0.00	68	19	14	230	28	11	3.2	302	246	0.3	7.4
Blackfoot, Idaho	20	0.02	83	26	20	290	44	14	--	396	314	0.4	7.3
Buhl, Idaho	67	0.10	51	5	74	150	83	47	3.2	454	150	1.9	8.2
Burley, Idaho	50	0.05	30	9	45	124	25	40	--	286	113	0.5	7.4
Driggs, Idaho	--	0.12	39	9	0	130	3	0	--	150	135	0.0	7.9
Filer, Idaho	--	0.03	148	42	58	376	168	83	--	926	543	1.2	7.9
Gooding, Idaho	--	0.02	50	16	16	164	35	18	--	292	191	0.2	7.6
Hailey, Idaho	--	0.01	34	22	4	166	14	4	--	188	175	0.0	7.7
Idaho Falls, Idaho ("I" St. Well)	27	0.15	61	21	21	214	43	17	0.5	334	238	0.1	7.8
Jerome, Idaho	18	0.10	43	15	31	152	39	27	3.6	282	168	0.4	7.7
Kimberley, Idaho	--	0.03	47	35	134	268	164	70	--	658	262	0.3	8.0
Rexburg, Idaho	22	0.00	52	16	9	192	9	6	5.4	238	192	0.4	7.4
Rupert, Idaho	43	0.20	37	10	153	188	4	192	0.0	518	132	0.9	7.6
Shelley, Idaho	31	0.03	61	22	33	214	46	34	5.4	364	243	0.2	7.5
Shoshone, Idaho	25	0.00	43	14	10	178	18	9	4.5	233	164	0.2	7.7
St. Anthony, Idaho	--	0.10	17	6	14	86	3.1	6	--	152	69	1.3	6.8

The sedimentary aquifer unit has dissolved solids which are generally less than 500 mg/l; the water is usally moderately hard to hard--sometimes very hard; and the chief anions are bicarbonates and sulfates.

In general, the only quality problems associated with ground-water supplies are local bacteriological contamination from humans, livestock, or irrigation. The high porosity of most soils generally allows the rapid movement of bacteria to the aquifers. Careful monitoring of ground-water sources is needed in several areas to prevent the occurrence of severe public health hazards.

Treatment

Table 50 summarizes water treatment practices of communities in the subregion. At least disinfection is provided for all surface or combined water supplies. The majority of communities utilizing ground water do not provide disinfection before distribution.

Henrys Fork Subbasin

Municipal

About 11,650 persons in the Henrys Fork Subbasin, or 55 percent of the population, are served by municipal water systems. Most of the 3.0 mgd water demand is centered in the Rexburg area, including the communities of Rexburg, St. Anthony, Sugar City, Teton, Newdale, and Parker.

Ground water is the major source of water supply, with surface-water supplies used only in the town of Driggs, which supplements well and spring sources with water drawn from Teton Creek.

Table 50 - Summary of Municipal Water Sources and Treatment Practices, Subregion 4

Source	Number of Municipal Facilities	Population Served Thousands	Percent of Total Population
Surface			
No treatment	-	-	-
Disinfection	1	1.7	0.9
Complete	-	-	-
	1	1.7	0.9
Ground			
No treatment	43	52.1	28.8
Disinfection	18	66.3	36.7
Complete	-	-	-
	61	118.4	65.5
Mixed			
No treatment	-	-	-
Disinfection	2	40.2	22.2
Complete	1	20.5	11.4
	3	60.7	33.6
Total	65	180.8	100.0

In general, the ground water is of excellent quality. Proposals for diversion of the Henrys Fork into a system of channels and ponds for the purpose of accelerating ground-water recharge have caused concern to the Idaho Department of Health because of the possibility of ground-water contamination. The concern is based on the high porosity of the soils involved, their limited filtering action, and the possibility of bacteria finding a suitable environment in the subsurface rivers that characterize the aquifer underlying the Snake Plain. While many years of subirrigation have produced little visible evidence of contamination

in the area, there is evidence of such contamination in the vicinity of Idaho Falls.

Industrial

A relatively small amount of water is used by industries in the Henrys Fork Subbasin. The major users are the milk products and potato-processing industries in the Rexburg area, requiring 0.4 and 0.5 mgd, respectively. Generally, adequate independent ground-water supplies have been developed by these industries.

Rural-Domestic

The rural-domestic water demand in the subbasin is approximately 2.4 mgd, including 1.2 mgd for domestic purposes and 1.2 mgd for livestock watering. Particularly heavy livestock watering requirements exist in the upriver areas of the Henrys Fork. Feedlot operations in such areas result in large, concentrated water needs. In general, water for domestic purposes is obtained from adequate ground-water supplies. The water quality is excellent in most cases, although local bacterial contamination has been noted in shallow wells.

Snake Plain Subbasin

Municipal

The municipal water requirement of about 3.6 mgd is scattered throughout the large Snake Plain Subbasin. The largest municipal water demand center is in the Gooding-Shoshone area, which has a requirement of about 1.1 mgd. The communities of Arco, Hailey, and Sun Valley also have important water uses.

All communities in the subbasin rely on ground-water supplies, generally from the vast Snake Plain aquifer, which constitutes one of the most productive ground-water sources in the United States. Wells in the aquifer commonly yield water at the rate of 1,000 to 3,000 gpm.

Industrial

There are no major industrial water users in the Snake Plain Subbasin. However, the National Reactor Testing Station (NRTS), the largest user of the Snake Plain aquifer, utilizes about 4.1 mgd.

The station uses most of the water for cooling purposes, returning about 3.3 mgd to the ground, including about 2.0 mgd of low-level radioactive liquids. These radioactive wastes are

released to the ground-water table from wells and seepage ponds after careful monitoring. In addition, wells serving the facilities and off-site sampling locations are included in a systematic program of water sampling and analysis. No evidence of an addition to the natural radioactivity of the aquifer by NRTS discharge has been found. As a result, the NRTS during 1966 curtailed the number of its off-site sampling stations, including the stations sampling the main source of ground-water inflow in the Thousand Springs area. While no problems of ground-water contamination have been reported, the opportunities for accident in a situation marked by the transfer of high level radioactive liquid wastes and the lack of knowledge of the behavior of water and radionuclides in the aquifer give rise to a concern as to the overall adequacy of the NRTS monitoring and waste control programs.

Rural-Domestic

The rural-domestic water requirement in the subbasin is larger than either the municipal or the industrial water demand. There is an average water requirement of about 8.7 mgd, including 5.5 mgd for domestic purposes and 3.2 mgd for livestock watering.

About 43,870 persons, or 76 percent of the subbasin population, are served by individual water systems. In general, the rural population is located in the northwestern and western sections of the subbasin, with sparse population in the flat, arid section of the Snake Plain. Both domestic and livestock water needs are usually obtained from ground-water sources of adequate quality and quantity.

Main Stem Snake Subbasin

Municipal

The Main Stem Snake Subbasin has the largest municipal water requirement in the subregion. About 154,990 persons, or 70 percent of the subbasin population, are served by municipal water facilities. Municipalities in the subbasin have an average annual water requirement of 39.0 mgd. Most of this demand is centered in the Idaho Falls, Pocatello, Burley, and Twin Falls Service Areas.

The Idaho Falls Service Area, which includes the communities of Idaho Falls, Shelley, Ucon, Lincoln, Iona, and Ammon, has an average annual municipal water requirement of about 9.8 mgd, coming from ground water. In and near the City of Idaho Falls there have been persistent problems of ground-water bacterial

contamination thought to be the result of the discharge of separate storm sewers into dry wells. Because of the extreme porosity of soils in the general region, bacteria are moved rapidly in the aquifer.

The Pocatello Service Area has an average annual municipal water need of 10.2 mgd, the largest in the subregion. Although ground water is the principal source supplying municipal water in the subregion, the City of Pocatello does supplement a ground-water supply with surface water. In general, the quantity and quality of surface and ground water used for water supplies in the service area are satisfactory for most purposes. However, effects of the operation of phosphate plants along the Portneuf River west of Pocatello have extended to certain ground waters underlying the area. Flows from Batiste Springs, a major aquifer termination point which discharges into the Portneuf River at a point just above its mouth, have demonstrated steadily rising concentrations of phosphates and fluorides. Phosphate concentrations of 0.1 mg/l in the early 1950's have climbed to about 15 mg/l at present.

The Burley Service Area, which includes the cities of Burley, Heyburn, Paul, and Rupert, withdraws an average of 3.4 mgd from wells for municipal purposes. No problems related to water quality or quantity have been reported in the service area.

The Twin Falls Service Area, which includes the cities of Twin Falls, Jerome, Buhl, Kimberly, Filer, and Hansen, has an average annual municipal water demand of about 8.3 mgd. Ground water is the principal source supplying municipal water requirements in the service area. The City of Twin Falls has, in the past, supplemented its supply of ground water with water drawn from the South Side Twin Falls Canal out of Milner Reservoir. The surface source was entirely abandoned, and emergency supplies were developed during critical periods because of recurring winter taste and odor problems associated with fish kills. Twin Falls is now using an entirely new source of water from springs on the opposite side of the Snake River Gorge. The quality and quantity of ground-water supplies in the service area are generally adequate for most municipal purposes.

Outside of the four major service areas, an additional municipal water requirement of 7.3 mgd exists in the subbasin. The only areas of significant water use are in and near Rigby, Blackfoot, and American Falls. These areas require 0.9, 2.0, and 0.9 mgd, respectively. In the Wyoming portion of the subbasin, Afton and Jackson each have average municipal water uses of about 0.4 mgd. In addition, heavy demands are made on the Jackson system by the tourist industry during the months of

June through September. The remaining municipal water requirement of 2.7 mgd is scattered widely. With the exception of Afton, Wyoming, all communities rely on ground-water sources. In general, the quantity and quality of ground water available are adequate for most municipal purposes. The only significant problem occurs in the American Falls area, where the nonoverflow lagoons of a potato-processing plant are a possible source of ground-water contamination.

Industrial

The industrial water requirement in the Main Stem Snake Subbasin is 67.3 mgd, or nearly one-half of the total municipal, major industrial, and rural-domestic water demand for the Upper Snake Subregion. The principal industries are phosphate processing, sugar refining, potato processing, and milk products. These industries have average water needs of about 37.0, 14.2, 9.4, and 6.1 mgd, respectively. Minor industrial water uses include meat products, and canning and freezing.

Industries in the four service areas account for about 96 percent of the total industrial water demand in the subbasin. The largest water use is in the Pocatello Service Area, where the chemical industries utilize about 37.0 mgd. In the Idaho Falls and Burley Service Areas, sugar refining and potato processing are the principal industrial water uses. In Idaho Falls, several food processing industries need 6.9 mgd. In Burley, several food processors require about [illegible].1 mgd. The food processing industry in the Twin Falls Service Area requires about 8.5 mgd.

Ground water is extensively used by industries in the subbasin. Most significant industrial water users have developed adequate independent ground-water supplies, although a few are served by municipal systems. There have been no reported cases of poor ground-water quality limiting any industrial use in the subbasin.

Rural-Domestic

Rural-domestic water use is important in the Main Stem Snake Subbasin, with approximately 16.7 mgd required to satisfy this demand. The rural population of about 68,010 persons has a water need of 8.6 mgd. Livestock watering in the subbasin has a requirement of 8.1 mgd.

In most cases, the rural population relies on individual water supplies drawn from ground-water sources, the quality and

quantity of which are generally adequate for most purposes. However, local bacterial contamination of ground-water supplies has occurred in certain areas. This usually results from wastes of human or livestock origin moving rapidly into the aquifers through the porous soils characterizing the subbasin. Irrigation has also been a contributor to ground-water contamination of several rural supplies.

FUTURE NEEDS AND MEANS TO SATISFY NEEDS

At present, 31 percent of the 145.7 mgd municipal, industrial, and rural-domestic water requirement in Subregion 4 is used for municipal purposes, 50 percent is used by industries, and 19 percent is used for rural-domestic purposes. In the future, the need for industrial water supply is expected to increase faster than the need for either municipal or rural-domestic supply. By 2020, industry is expected to utilize 54 percent of the 459.5 mgd projected demand. The municipal need will increase to 34 percent of the total requirement, and the rural-domestic demand will decrease to 12 percent. Total needs are expected to more than triple by 2020.

The estimated population of 302,000 in 1965 is projected to increase to 576,500 by 2020. This represents an increase of only 91 percent, compared with a regional increase of 121 percent. By 2020, 72 percent of the subbasin population will be concentrated in the four service areas. Only 12 percent of the population will reside in rural areas.

Production of the major water-using industries is projected to more than double between now and 2020 in terms of dollar value to the subregion. It is anticipated that food and chemical products will continue to be the major industries between now and 2020, although establishment of a significant pulp and paper production facility is likely.

Municipal

Basis for Water Supply Projections

The projected population to be served by municipal water systems in 1980, 2000, and 2020 is shown in table 51. By 2020, it is expected that about 91 percent of the population will be served by central systems. Projected municipal water requirements are based on population estimates shown in table 51, and on per capita water demands presented in the "Future Needs" section of the Regional Summary. Average needs for the subregion are

Table 51 - Projected Population, Subregion 4

	1980	2000	2020
	------------	Thousands	------------
Henrys Fork Subbasin	23.0	24.5	25.9
Municipal	13.8	15.5	17.4
Rural	9.2	9.0	8.5
Snake Plain Subbasin	63.0	68.0	75.0
Municipal	19.1	24.5	32.5
Rural	43.9	43.5	42.5
Main Stem Snake Subbasin	264.9	358.0	475.6
Idaho Falls Service Area	67.6	106.0	150.3
Municipal	60.0	106.0	150.3
Rural	7.6	--	--
Pocatello Service Area	56.7	79.0	102.1
Municipal	56.7	79.0	102.1
Rural	--	--	--
Burley Service Area	24.7	38.1	57.9
Municipal	24.7	38.1	57.9
Rural	--	--	--
Twin Falls Service Area	49.3	69.6	104.6
Municipal	49.3	69.6	104.6
Rural	--	--	--
Other	66.6	65.3	60.7
Municipal	32.4	37.2	40.6
Rural	34.2	28.1	20.1
Subtotal	264.9	358.0	475.6
Municipal	223.1	329.9	455.5
Rural	41.8	28.1	20.1
Total Subregion	350.9	450.5	576.5
Municipal	256.0	369.9	505.4
Rural	94.9	80.6	71.1

expected to increase from 255 gpcd in 1965 to 275 gpcd in 1980, 295 gpcd in 2000, and 310 gpcd in 2020.

Projections of Water Supply Requirements

Projected municipal water requirements for 1970, 1980, 2000, and 2020 are shown in table 52 by subbasin and service area. By 2020, about 82 percent of the subregion's municipal water need is expected to occur in the four service areas of Idaho Falls, Pocatello, Burley, and Twin Falls. The balance of the demand will be scattered, with the towns of Rexburg, St. Anthony, Rigby, Blackfoot, and Gooding requiring significant amounts. All persons within the major service areas will be served by public water systems by the end of the projection period. At that time, 128.1 mgd will be required in the four service areas, 12.6 mgd in other municipalities in the Main Stem Snake Subbasin, 5.5 mgd in communities in the Henrys Fork Subbasin, and 10.2 mgd in the Snake Plain Subbasin.

Table 52 - Projected Municipal Water Use, Subregion 4

	1970	1980	2000	2020
	MGD			
Henrys Fork Subbasin	3.3	3.9	4.6	5.5
Snake Plain Subbasin	4.1	5.3	7.4	10.2
Main Stem Snake Subbasin				
Idaho Falls Service Area	12.0	16.5	31.3	46.7
Pocatello Service Area	12.0	15.6	23.3	31.7
Burley Service Area	4.5	6.6	11.1	17.7
Twin Falls Service Area	10.1	13.6	20.4	32.0
Other	7.9	9.1	11.0	12.6
	46.5	61.4	97.1	140.7
Total	53.9	70.6	109.1	156.4

Problems and Solutions

Most existing water supply sources are considered adequate to meet future needs. It is expected that in the future all supplies will be provided at least disinfection and that most surface supplies will require complete treatment. Areas where quantity

and/or quality problems are expected to interfere with the development of supplies to meet future needs are discussed below by subbasin.

Henrys Fork Subbasin Most of the municipal water needs in this subbasin are obtained from the Snake Plain aquifer, a plentiful source of high quality water. Demands to meet future growth will be met primarily from this source.

Because of the permeable characteristics and limited filtering action of the strata overlying the Snake Plain aquifer, contamination of the ground water from surface sources is a constant threat. Disposal of septic tank effluents and agricultural waste waters into drainage wells could seriously impair the quality of water for use. The Idaho Department of Health, in cooperation with the University of Idaho and the Federal Water Quality Administration, is presently engaged in studies to determine the characteristics of waste waters now being discharged to drainage wells, and to assess the impact of these wastes on the ground water.

The Snake Plain Recharge Project, which is under investigation by the Bureau of Reclamation, entails the diversion of Henrys Fork surplus flows onto seepage areas of the Snake Plain to increase the quantities of ground water available for irrigation and other uses. The Idaho Department of Health has expressed concern that bacteria and sediment carried by the recharge waters will degrade the quality of the aquifer. This possibility, and possible corrective measures, should be considered in detail as part of the project planning work.

Snake Plain Subbasin Most communities in the subbasin rely on ground-water supplies from the Snake Plain aquifer. No problems are anticipated in meeting future needs from a quantity standpoint. Quality could be a problem, however, as discussed in the preceding discussion under the Henrys Fork Subbasin. In addition, low-level radioactive wastes are discharged to the aquifer from the Atomic Energy Commission National Reactor Testing Station at Arco. While no problems have occurred in the past because of these wastes, the fact that these radioactive materials are located above the aquifer is a threat to its quality. An accidental spill of "hot" wastes, corrosion of one of the tanks storing high-level wastes, or flooding of the area where solid radioactive wastes are buried, are potential sources of ground-water contamination. Continuation of the AEC waste treatment and control practices program of monitoring ground water will minimize the threat.

Industrial

Basis for Water Supply Projections

Projected industrial water supply requirements are based on growth indices derived from data presented in Appendix VI, and on present water use for each industrial category. Water use per unit of product was assumed to remain unchanged for purposes of estimating future demands.

Projections of Water Supply Requirements

Projections of industrial water needs to 2020, by category, are shown in table 53. Food products and chemical products are industrial activities that are assumed to grow at the rates shown by the appropriate indices. There is no pulp and paper production in the subregion at present, but the projections assume that a plant utilizing 10.0 mgd will be in operation by 2000, and that the production will increase to a point where 35.0 mgd will be required by 2020. The "Other" category represents the existing water use at the National Reactor Testing Station near Arco. No increased water needs are projected for this installation. Industrial water needs are expected to more than triple by 2020.

Table 53 - Projected Industrial Water Use, Subregion 4

	1970	1980	2000	2020
	MGD			
Food products	38.4	53.0	76.8	97.5
Chemical products	43.2	55.6	81.6	112.0
Pulp and paper	-	-	10.0	35.0
Other	4.1	4.1	4.1	4.1
Total	85 .7	112.7	172.5	248.6

The "Chemical Products" category, which represents the phosphate-processing plants near Pocatello, is the largest water user at present. This industry is expected to grow at a rate comparable with that of the food products industry and will still be the largest single user of industrial water by 2020, utilizing 45 percent of the total 250 mgd projected industrial water need. Food products will be a close second with 39 percent of the total demand, followed by pulp and paper with 14 percent, and "Other" (NRTS installation) with 2 percent.

It is assumed that, for most industries, future growth will occur in the vicinity of existing operations. Based on that assumption, future demands for food processing will occur in the Idaho Falls, Burley, and Twin Falls Service Areas. Industrial demands for chemical products processing will take place in the Pocatello Service Area. A need for water for the pulp and paper industry is expected to occur near Bliss, Idaho. By 2020, industrial water use should total 27.5 mgd in the Idaho Falls Service Area, 25.9 mgd in the Burley Service Area, 31.0 mgd in the Twin Falls Service Area, 115.4 mgd in the Pocatello Service Area, and 35.0 mgd near Roberts. The projected industrial water use at these five locations represents about 94 percent of the total 2020 demand.

The primary industrial water use at Idaho Falls, Burley, and Twin Falls is for potato processing and sugar refining. Under present operational procedures, these industries reach a peak output during the fall and winter and do not operate at all during much of the summer. Table 11 in the Regional Summary shows the monthly distribution of the average annual water demand by industrial category.

Problems and Solutions

Future industrial water needs are expected to be met from ground water and springs where possible. Problems with the quantity and quality of municipal water supplies, discussed previously, also apply to industrial supplies.

Rural-Domestic

Basis for Water Supply Projections

Future water needs for domestic use in rural areas are based on an average annual per capita use figure applied to the projected rural population shown in table 54. Per capita domestic water use was assumed to be about 50 percent of that used in nearby municipalities at present. This per capita use figure was assumed to increase to 60 percent of that used in nearby communities in 1980, 70 percent of the municipal use in 2000, and 80 percent of the municipal use in 2020. Based on these assumptions, domestic water needs are expected to increase from 125 gpcd in 1965 to 165 gpcd by 1980, 205 gpcd by 2000, and 250 gpcd by 2020.

Projections of Water Supply Requirements

Anticipated rural-domestic water requirements are presented in table 54 by subbasin for the years 1970, 1980, 2000, and 2020. The 30.4 mgd present usage is expected to increase to 53.4 mgd by 2020, with the growth fairly well distributed throughout the subregion. Approximately one-third of the projected 2020 total need will be used for domestic purposes.

Table 54 - Projected Rural-Domestic Water Use, Subregion 4

	1970	1980	2000	2020
	MGD			
Henrys Fork Subbasin				
Domestic	1.3	1.5	1.9	2.1
Livestock	1.4	1.9	2.6	3.4
	2.7	3.4	4.5	5.5
Snake Plain Subbasin				
Domestic	6.1	7.2	9.0	10.5
Livestock	3.8	5.1	7.0	9.2
	9.9	12.3	16.0	19.7
Main Stem Snake Subbasin				
Domestic	8.0	6.9	5.8	5.0
Livestock	9.8	13.0	17.7	23.2
	17.8	19.9	23.5	28.2
Total				
Domestic	15.4	15.6	16.7	17.6
Livestock	15.0	20.0	27.3	35.8
	30.4	35.6	44.0	53.4

Problems and Solutions

The principal problem in attempting to satisfy future rural-domestic water needs is expected to be one of quality, rather than quantity. No serious problems are foreseen in additional development of existing supplies to meet future needs. Contaminated supplies could become a problem, however, which would require disinfection of each supply by the individual user. Problems with contaminated ground-water supplies could be minimized through careful location and design of the wells.

LOCATION MAP

SUBREGION 5

SUBREGION 5

CENTRAL SNAKE

INTRODUCTION

The Central Snake is the largest subregion, containing 36,825 square miles in the states of Idaho, Oregon, and Nevada. The largest portion of the subregion lies within the Snake River Plateau province. The area is bounded on the northeast by the Northern Rocky Mountains, on the northwest by the Blue Mountains, and on the west and southwest by the Great Basin.

The climate is similar to that of other subregions east of the Cascade Range--hot, dry summers and cool winters, during which most of the precipitation falls. Average annual temperatures range from 40 to 50°F., and extreme temperatures have ranged from -49° to 117°F. The plateau receives only 6 to 15 inches of precipitation a year, while the mountains average as much as 60 inches. Much of the precipitation at higher elevations is in the form of snow, providing water to streams until July. Summer droughts are a common characteristic, with precipitation averaging less than an inch throughout much of the subregion. The growing season ranges from 160 days in the lower valleys to less than 60 days in the mountain valleys.

The streamflow regimen of the central Snake River and tributaries is characterized by high flows from early spring through the first part of summer and low flows from late summer through the winter. The maximum floods occur during the snowmelt period between March and late June.

The economy is based largely on agricultural production and processing. The principal crops grown and processed are potatoes and sugar beets. The processing of livestock, dairy, and poultry products is also of importance. There is a limited amount of manufacturing in the Boise area.

The population of the subregion, which is about 268,500, is concentrated in the area extending from Boise into eastern Oregon. As a result, large areas are very sparsely populated.

Subregion 5 is divided in terms of significant subbasins and major service areas to facilitate explanation in this appendix. The three major subbasins (figure 6) are the Boise, Payette-Weiser, and Snake River and Other Tributaries. The major service

areas are the Boise and the Ontario-Payette, which contain over three-fifths of the subregion's total population.

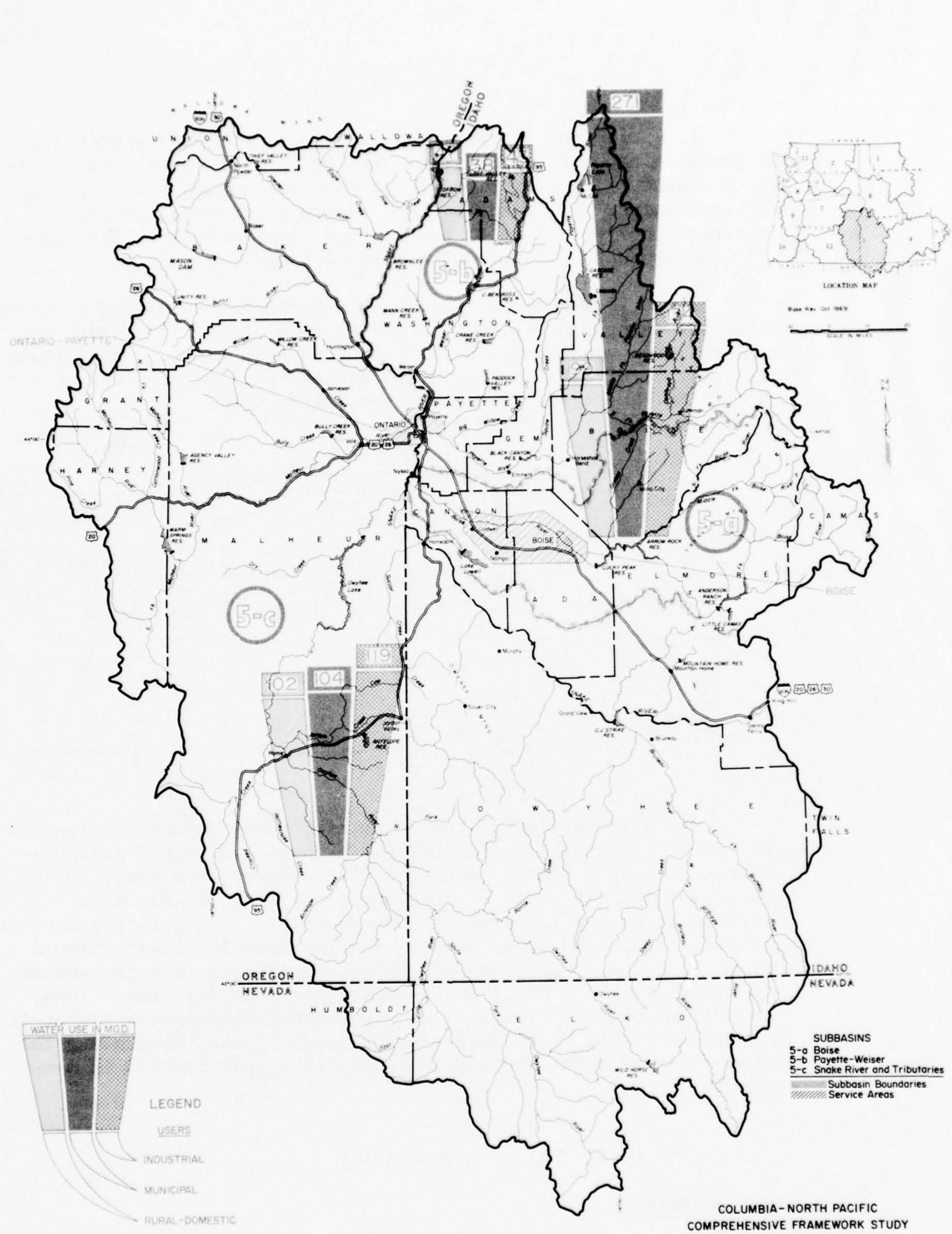
PRESENT STATUS

Table 55 is a summary of present municipal, major industrial, and rural-domestic water currently required in the subregion. At present, the water requirement averages about 95.7 mgd, including a municipal demand of 41.3 mgd, an industrial demand of 29.6 mgd, and a rural-domestic demand of 24.8 mgd. These needs are generally concentrated in the major service areas. The Boise and Ontario-Payette Service Areas require about 50.2 and 14.3 percent, respectively, of the subregion's average annual water needs.

Table 55 - Present Municipal, Major Industrial, and Rural-Domestic Water Supply Needs, Subregion 5

	Municipal	Industrial	Rural-Domestic	Total	% Total Subregion
	MGD				
Boise Subbasin					
Boise Service Area	26.2	13.4	8.4	48.0	50.2
Other	0.9	-	1.5	2.4	2.5
	27.1	13.4	9.9	50.4	52.7
Payette-Weiser Subbasin	3.8	4.3	4.7	12.8	13.4
Snake River and Other Tributaries Subbasin					
Ontario-Payette Service Area	2.9	10.3	0.5	13.7	14.3
Other	7.5	1.6	9.7	18.8	19.6
	10.4	11.9	10.2	32.5	33.9
Total	41.3	29.6	24.8	95.7	100.0

About 62 percent of the population is served by municipal water systems. Approximately 92.4 percent of the systems depend on ground-water sources, 6 percent on mixed supplies, and only 1.6 percent on surface-water sources.



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

WATER USE

CENTRAL SNAKE SUBREGION 5

1969

FIGURE 6

The principal industrial water use is for food processing. It requires about 82 percent, or 24.3 mgd, of the total industrial water demand. The most significant food-processing industries are sugar refining, milk products, and potato processing. These industries require 13.5, 4.6, and 3.2 mgd, respectively. The lumber and wood products industry uses about 4.6 mgd.

Table 56 summarizes the monthly variation in demand by major water-use categories in each of the service areas. Since no data are available concerning the municipal monthly pattern, a statistical analysis of water supply distribution for similar areas in the Pacific Northwest was used to derive the figures.

Table 56 - Monthly Variation in Water Needs, Subregion 5

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	Percent											
Boise Service Area												
Municipal	67	70	71	86	90	143	186	145	121	81	72	66
Sugar refining	169	169	169	51	0	0	0	0	135	169	169	169
Milk products	99	89	100	106	118	118	112	106	99	89	83	89
Potato processing	132	132	125	125	104	0	0	42	125	139	139	139
Canning & freezing	0	0	0	70	141	106	141	460	282	0	0	0
Meat products	103	82	93	98	98	98	98	109	109	109	98	109
Ontario Service Area												
Municipal	67	70	71	86	90	143	186	145	121	81	72	66
Sugar refining	169	169	169	51	0	0	0	0	135	169	169	169
Potato processing	132	132	125	125	104	0	0	42	125	139	139	139
Canning & freezing	0	0	0	46	70	46	139	462	322	70	46	0
Milk products	95	89	101	107	118	118	112	107	95	89	83	89
Meat products	103	82	93	98	98	98	98	109	109	109	98	109
Lumber & wood products	100	100	100	100	100	100	100	100	100	100	100	100

The distribution of the industrial water demand is significant in that food-processing activities have a distinct seasonal pattern. Sugar refining occurs in fall, winter, and early spring, starting about the first of September, building rapidly to a December peak, and tapering off during April. The potato-processing period overlaps the sugar season, running from September through May at high levels and, in some cases, continuing into the summer with inshipments or utilization of the early summer crop. Thus, the current pattern of use finds high summer municipal and domestic use complementing high winter food-processing use, indicating the feasibility of joint municipal-industrial supply systems in many places.

Water Quality

Surface Water

With the exception of the Snake, Bruneau, Malheur, and Owyhee Rivers and the lower reaches of the Boise River, the

surface waters are of adequate quality for municipal and industrial purposes with only minimal treatment. The most common problems associated with these waters are sediment, bacteria, algae, and troublesome trace elements.

The Boise, Payette, and Weiser Rivers are calcium-magnesium bicarbonate type waters with low dissolved solids (less than 100 mg/l) as they leave the headwater areas. The other streams draining the subregion (Bruneau, Owyhee, Malheur, and Powder Rivers) are typical of tributaries for most semiarid basins of the Snake River. They contain relatively low dissolved solids (100 to 200 mg/l) and are bicarbonate type waters in their upper reaches. The amounts of calcium and sodium vary, with calcium usually predominating during the high flow periods. During most of the year, however, sodium is the predominant cation. Most of the streams show dramatic downstream changes in mineral quality as a result of irrigation diversions and return flows. The dissolved solids can increase tenfold or more, and the chemical composition is altered. The Owyhee, Boise, and Malheur Rivers show the greatest changes. Dissolved solids values over 1,000 mg/l have been reported in the Malheur River, and the water at the mouth is a sodium carbonate-sodium sulfate type.

The waters of the Bruneau River and some of its tributaries contain fluoride concentrations in excess of the limits set for drinking waters by the Public Health Service. The average fluoride concentration of six samples collected from Little Valley Creek near Bruneau was 9.5 mg/l. Ten samples collected from the Bruneau River at Hot Springs during the 1959 water year averaged 2.7 mg/l fluoride.

The Snake, Owyhee, Malheur, and lower Boise Rivers are burdened by heavy algal growths during much of the year. These algal growths tend to cause objectionable taste and odors, maintenance and transmission problems, and unsightly conditions in the rivers.

Most streams contain high sediment concentrations during periods of high runoff. The lower Boise River and the Snake River below its confluence with the Boise also contain suspended organic material from food-processing wastes.

The bacterial quality of streams is highly variable. Many areas have shown coliform densities greater than the limit recommended for human consumption. However, a significant portion of the high bacterial counts may be attributable to large animal populations, plants, and soil bacteria. The available information indicates poor bacterial quality in most streams at the sampling stations. This situation may not be representative of all subregional streams.

Ground Water

A summary of mineral quality data for several ground-water supplies in the subregion is presented in table 57. The chemical quality data indicate that, except in a few localities, ground water is satisfactory for most municipal and industrial purposes. The problems associated with ground-water quality are generally excessive concentrations of troublesome, scale-forming salts and trace constituents, and bacterial contamination as a result of septic tank discharges.

Table 57 - Mineral Water Quality of Ground-Water Supplies, Subregion 5

	SiO_2	Fe	Ca	Mg	Na	HCO_3	SO_4	Cl	NO_3	Total Solids	Hard. $CaCO_3$	F	pH
	mg/l												
Boise, Idaho (Mountain View Gallery)	14	0.05	11	1.7	8	44	4.6	1	0.9	169	34	0.3	6.6
(Fairview Well)	21	0.02	22	1.5	18	82	13	3	0.0	131	62	0.3	7.4
Caldwell, Idaho (Rose Garden Well)	33	0.02	11	2.6	1	60	5.4	2	--	106	39	0.4	7.4
Emmett, Idaho	27	0.50	29	2.5	22	108	3	11	0.0	150	82	1.4	7.7
Council, Idaho	--	0.00	14	7	11	76	10	1	--	128	63	0.3	7.3
Homedale, Idaho	72	0.10	12	3	159	296	34	27	23.9	524	40	0.7	7.8
Mountain Home, Idaho	37	0.10	17	7	12	88	7.2	2	0.0	140	72	0.2	7.2
Nampa, Idaho	28	0.00	13	2	87	132	8.2	7	0.0	185	40	1.5	7.6
New Plymouth, Idaho	35	0.10	8	1	43	114	0	2	0.0	194	26	0.6	7.7
Parma, Idaho	71	0.03	29	7	79	214	25	21	1.3	361	102	0.8	8.1
Payette, Idaho	--	0.30	40	16	46	222	30	9	0.0	290	167	0.1	7.9
Adrian, Oregon	65	--	11	2	200	290	0	85	--	602	35	1.3	8.3
Ontario, Oregon (Well 1)	34	0.05	39	66	80	250	118	34	0.36	506	369	0.8	8.2
Vale, Oregon (Well 1)	53	0.05	56	92	162	390	306	77	2.4	1051	517	0.6	7.9

In general, the dissolved solids concentration of most ground waters is less than 500 mg/1, except where percolating irrigation water has increased the mineral content. The water may be soft to very hard, depending upon the location of the well. The water is generally a calcium bicarbonate type, although sodium and sulfate are sometimes present in high percentages. Fluorides are sometimes above the limit recommended by the PHS Drinking Water Standards.

The City of Boise has recently been experiencing some rather serious, and apparently increasing water quality problems. Some wells are producing water with excessive concentrations of fluoride, and severe nuisance conditions in the form of taste, odor, and color have occurred within several public water systems, as a result of the high iron and/or manganese concentrations. A portion of the problem appears to result from inadequate

disinfection of wells and steel pipelines, resulting in growths of iron and sulfur bacteria. However, in the opinion of the Idaho State Department of Health (the agency responsible for maintaining water quality surveillance of municipal water systems), the water quality problems are likely to continue increasing as larger quantities of water are drawn from the ground-water aquifer.

Treatment

A summary of municipal water treatment practices of communities in the subregion is presented in table 58. Mineral removal and specialized treatment are not listed. At least disinfection is provided for all surface or mixed water supplies. Over one-half of the communities utilizing ground-water supplies provide disinfection before distribution. The City of Ontario has a complete treatment plant for softening and disinfection.

Table 58 - Summary of Municipal Water Sources and Treatment Practices, Subregion 5

Source	Number of Municipal Facilities	Population Served Thousands	% of Total Population
Surface			
No treatment	-	-	-
Disinfection	2	2.7	1.6
Complete	-	-	-
	2	2.7	1.6
Ground			
No treatment	14	27.5	16.6
Disinfection	17	120.4	72.7
Complete	1	5.1	3.1
	32	153.0	92.4
Mixed			
No treatment	-	-	-
Disinfection	1	10.0	6.0
Complete	-	-	-
	1	10.0	6.0
Total	35	165.7	100.0

Boise Subbasin

Municipal

Approximately 68 percent of the population in the Boise Subbasin, or 109,800 persons, are served by municipal water systems. This population has an average annual water need of about 27.1 mgd. Most of the water requirement is centered in the Boise Service Area, which includes the cities of Boise, Nampa, and Caldwell, and several small communities.

The City of Boise and the surrounding suburban area are served by the Boise Water Corporation from more than 20 wells. The city requires nearly 17 mgd for municipal purposes. Nampa and Caldwell are also served by numerous wells and have water demands of 4.7 and 3.1 mgd, respectively. Other small communities in the service area utilize from one to three wells for supply. Their combined water need is about 1.5 mgd.

Ground-water sources are also used by all municipalities in the subbasin outside of the Boise Service Area. These communities have a total water requirement of only about 0.9 mgd.

Industrial

The industrial water demand in the Boise Subbasin is about 13.4 mgd. All of this requirement is centered in the Boise Service Area. The principal water-using industries are sugar refining, potato processing, and milk products. These industries have average water needs of about 6.4, 1.6, and 3.9 mgd, respectively. Minor industrial water uses include meat products and canning and freezing.

A large food processing industry has an annual average water requirement of 6.4 mgd; however, from October to March the monthly demand averages about 20 mgd. Several milk products plants at Boise have a combined average water requirement of about 3.3 mgd. Food processing plants at Caldwell require about 1.5 mgd. Other industrial water uses are relatively minor.

In general, most industries have developed independent ground-water supplies, although a few of the small water users are served by municipal systems.

Rural-Domestic

The rural-domestic water requirement in the Boise Subbasin is about 9.9 mgd. The rural population of about 52,000 persons has a water need of 6.5 mgd. Livestock watering requires 3.4 mgd. The stock-watering demand is of particular importance, since the Boise River Valley is the center of the subregion's cattle-feeding, dairy, and poultry industries.

The rural-domestic water needs are met largely from individual sources such as wells or ponds, although in some instances flows are maintained in irrigation canals throughout the year for these purposes. The trend in stock watering has been towards concentrated watering at specific points. This has resulted in large point demands for water.

Payette-Weiser Subbasin

Municipal

About 14,860 persons, or 46 percent of the population in the Payette-Weiser Subbasin, are served by municipal water systems. The municipal population has an average annual water need of 3.8 mgd. Most of this requirement is centered in the Emmett and Weiser areas.

The cities of Payette, New Plymouth, and Fruitland are physically located in the Payette-Weiser Subbasin, but for purposes of this study are considered to be a part of the Ontario-Payette Service Area, which is in the Snake River and Other Tributaries Subbasin.

The City of Weiser, Idaho, has a water need of about 1.3 mgd, which it obtains from two wells. An auxiliary supply, with filtration, is available on the Snake River for emergency purposes. The well supplies for Weiser have reportedly been inadequate to meet peak demands, and an influx of sand into the wells has caused pumping problems during summer runoffs.

The City of Emmett, Idaho, has an average water requirement of about 1.2 mgd. Adequate underground sources are utilized for its water supply.

The towns of Cascade and McCall, Idaho, are the only communities in the subbasin using water supplies from surface sources. McCall withdraws about 0.4 mgd from Payette Lake, and Cascade takes about 0.3 mgd from Cascade Creek.

Industrial

The industrial water use in the Payette-Weiser Subbasin is approximately 4.3 mgd. The principal water demand is for the lumber and wood products industry, which uses about 4.0 mgd.

The largest water user is the lumber industry at Emmett, which requires 2.5 mgd. A number of smaller lumber mills at Cascade, Council, McCall, Midvale, Horseshoe Bend, and Tamarack have a combined water use of about 1.5 mgd.

The only other major industrial water use is by the food processing industry at Emmett. This industry requires about 0.3 mgd.

Rural-Domestic

The rural-domestic water use in the Payette-Weiser Subbasin is about 4.7 mgd. The rural population of approximately 17,540 persons has a water requirement of about 2.2 mgd. Livestock watering has a requirement of 2.5 mgd.

In most cases, the rural population relies upon individual water supplies drawn from ground-water sources. Water for livestock purposes is usually obtained from wells or ponds, but in some areas flows for stock watering are maintained in irrigation canals throughout the year.

Snake River and Other Tributaries Subbasin

Municipal

About 40,990 persons, or 55 percent of the population in the subbasin, are served by municipal water systems. This portion of the population has an average water requirement of about 10.4 mgd. Most of this need is centered in the Ontario-Payette Service Area and in the Baker, Oregon, and Mountain Home, Idaho, areas.

The Ontario-Payette Service Area, which includes the communities of Ontario, Oregon, and Payette, New Plymouth, and Fruitland, Idaho, has an average water requirement of about 2.9 mgd. All communities in the service area rely upon ground-water sources for their water supplies. The City of Ontario provides treatment of its water supply for hardness removal.

The cities of Baker, Oregon, and Mountain Home, Idaho, use 2.6 and 2.4 mgd, respectively. The remaining communities

have a combined water requirement of about 1.8 mgd. With the exception of Baker, all municipal supplies are obtained entirely from underground sources. The City of Baker withdraws its supply from creeks and reservoirs as well as from wells and springs.

Industrial

The industrial water requirement in the subbasin is about 11.9 mgd. The principal water-using industries are sugar refining and potato processing. These industries have average water needs of about 7.1 and 1.6 mgd, respectively. The canning and freezing, milk products, and lumber and wood products industries are relatively minor water users.

The Ontario-Payette Service Area accounts for about 90 percent of the total industrial water demand. The largest water use is by the food processing industry. The industry has an annual average water requirement of 7.1 mgd, but from October to March the monthly need averages over 20 mgd. Food processors at Ontario have an average water requirement of approximately 1.6 mgd. Food processors at Fruitland, Idaho have a water need of about 0.4 mgd. Several meat and milk products plants in the service area have a water demand of about 0.9 mgd. A plywood plant at Payette, Idaho, uses about 0.3 mgd.

The only major industrial water use outside of the Ontario-Payette Service Area is by a canning and freezing plant at Nyssa, a milk products plant at Baker, a cement plant at Lime, Oregon, and lumber mills at Halfway and Unity, Oregon. These industries use 0.4, 0.2, 0.7, and 0.3 mgd, respectively.

Generally, industries in the subbasin have developed adequate independent ground-water sources.

Rural-Domestic

Approximately 10.2 mgd are needed to satisfy this requirement. The rural population of about 33,310 persons has a water need of 4.1 mgd, and livestock watering has a requirement of 6.1 mgd.

In most cases, the rural population relies upon individual water supplies drawn from ground-water sources. Water for livestock is obtained primarily from wells, ponds, or streams, although in some instances flows for this purpose are maintained in irrigation canals throughout the year. The water need for livestock is concentrated along the Snake River between Adrian and Brownlee Reservoir.

FUTURE NEEDS AND MEANS TO SATISFY NEEDS

At present, 43 percent of the 95.7 mgd municipal, industrial, and rural-domestic water need in Subregion 5 is used for municipal purposes, 31 percent is used by industries, and 26 percent is used for rural-domestic purposes. In the future, the need for industrial water supply is expected to grow faster than the demand for either municipal or rural-domestic supplies. Municipal use will continue to dominate, however, utilizing 44 percent of the 333 mgd projected 2020 requirement. By 2020, the industrial need will increase to 40 percent of the total requirement, and the rural-domestic demand will decrease to 16 percent. Total demands are expected to more than triple by 2020.

The estimated population of 268,000 in 1965 is projected to increase to 553,000 by 2020. This represents an increase of 106 percent, compared with a regional increase of 121 percent. Table 59 shows projected population growth by subbasin and service area for 1980, 2000, and 2020. By 2020, 72 percent of the subregional population will be concentrated in the Boise and Ontario-Payette Service Areas. Only 14 percent of the population will reside in rural areas.

Production of the major water-using industries is projected to increase by more than 200 percent between now and 2020 in terms of dollar value to the community. It is anticipated that food processing will continue to be a major industry between now and the year 2020, with pulp and paper production contributing a significant amount.

Municipal

Basis for Water Supply Projections

The projected population to be served by municipal water systems in 1980, 2000, and 2020 is shown in table 59. It is expected that by 2020, about 86 percent of the population will be served by municipal systems. Projected municipal water needs are based on population estimates shown in table 59, and on per capita water requirements presented in the "Future Needs" section of the Regional Summary. Average requirements for the subregion are expected to increase from 255 gpcd in 1965 to 275 gpcd in 1980, 295 gpcd in 2000, and 310 gpcd in 2020.

Table 59 - Projected Population, Subregion 5

	1980	2000	2020
	-----------	Thousands	---------
Payette-Weiser Subbasin	40.8	51.0	57.5
Municipal	20.0	30.0	36.5
Rural	20.8	21.0	21.0
Boise Subbasin	199.7	278.3	381.6
Boise Service Area	182.2	259.8	362.1
Municipal	152.2	239.8	352.1
Rural	30.0	20.0	10.0
Other	17.5	18.5	19.5
Municipal	4.5	5.0	5.5
Rural	13.0	13.5	14.0
Subtotal	199.7	278.3	381.6
Municipal	156.7	244.8	357.6
Rural	43.0	33.5	24.0
Snake River & Other Tributaries Subbasin	88.2	101.1	114.4
Ontario-Payette Service Area	21.7	28.2	37.4
Municipal	21.7	28.2	37.4
Rural	--	--	--
Other	66.5	72.9	77.0
Municipal	33.3	38.9	42.0
Rural	33.2	34.0	35.0
Subtotal	88.2	101.1	114.4
Municipal	55.0	67.1	79.4
Rural	33.2	34.0	35.0
Total Subregion	328.7	430.4	553.5
Municipal	231.7	341.9	473.5
Rural	97.0	88.5	80.0

Projections of Water Supply Requirements

Projected municipal water requirements for the years 1970, 1980, 2000, and 2020 are shown in table 60 by subbasin and service area. By 2020, about 83 percent of the subregion's municipal water need of 145.7 mgd is expected to occur in the Boise and the Ontario-Payette Service Areas. The balance of the demand will be scattered throughout the subregion, with the towns of Baker, Oregon, and Emmett and Mountain Home, Idaho, requiring significant amounts. All persons within the Ontario-Payette Service Area, and all but about three percent of the population within the Boise Service Area, will be served by public water systems by the end of the projection period. At that time, 120.3 mgd will be required in these two service areas, 11.0 mgd will be required by municipalities in the Payette-Weiser Subbasin, and 14.4 mgd will be distributed to other communities in the subregion.

Table 60 - Projected Municipal Water Use, Subregion 5

	1970	1980	2000	2020
	MGD			
Snake River and Other Tributaries Subbasin				
Ontario-Payette Service Area	4.0	6.1	8.2	11.1
Other	8.0	8.9	11.1	12.7
	12.0	15.0	19.3	23.8
Payette-Weiser Subbasin	4.4	5.6	8.8	11.0
Boise Subbasin				
Boise Service Area	31.3	41.6	70.8	109.2
Other	1.0	1.3	1.5	1.7
	32.3	42.9	72.3	110.9
Total	48.7	63.5	100.4	145.7

Problems and Solutions

The Boise and Ontario-Payette Service Areas overlie a high-yielding ground-water aquifer that should easily supply the quantities needed to meet future demands. However, quality problems associated with excessive fluoride, iron, manganese, and bacterial concentrations have occurred in the Boise area in the past, and these problems are likely to continue as larger quantities of water are withdrawn from the aquifer. These supplies

are provided disinfection only at present but, if quality problems persist, specialized treatment to remove constituents causing taste, odor, and color problems will be required. The ready availability of ground water in the two major service areas will insure that projected growth in these areas is not curtailed by water supply limitations.

Both quantity and quality limitations could cause problems in attempting to satisfy future needs of some communities, particularly in the Oregon portion of the subregion. Many of these towns utilize wells, springs, or a combination of the two, to satisfy present needs. Since these sources are usually localized, each community will require an individual study to evaluate the capability of the present source to meet future needs, or to identify alternative sources of supply.

Industrial

Basis for Water Supply Projections

Projected industrial water supply demands are based on growth indices derived from data presented in Appendix VI, and on present water use for each industrial category. Water use per unit of product was assumed to remain unchanged for purposes of estimating future needs.

Projections of Water Supply Requirements

Table 61 shows the projected water requirements to 2020 by industrial category. By 2020, industrial water needs will total 134 mgd, about 40 percent of the subregion's total water supply demand. Food-processing industries, located primarily in the two major service areas, are the largest users at present and will continue to dominate throughout the projection period. Lumber and wood products industries, located primarily in the Weiser, Payette, and Powder River Basins, use relatively small amounts of water at present. Very little growth is projected for this category. There is no pulp and paper production in the subregion at present, but the projections assume that a plant utilizing 10.0 mgd will be in operation by 1980, and that production will increase until 50.0 mgd are required by 2020.

It is assumed that most industrial growth will occur in the vicinity of existing operations. Based on that assumption, over 96 percent of the future water need for food-processing industries will occur in the Boise and the Ontario-Payette Service Areas. About 87 percent of the water requirement for lumber

and wood products processing will take place in the Payette-Weiser Subbasin, with the balance of the demand occurring in communities such as Payette, Halfway, and Baker, which are near raw forest products. The need for water for pulp and paper production is expected to occur near Weiser, Idaho.

Table 61 - Projected Industrial Water Use, Subregion 5

	1970	1980	2000	2020
	MGD			
Food products	29.4	38.8	57.3	74.1
Lumber and wood products	4.8	5.2	5.6	5.2
Pulp and paper	-	10.0	26.0	50.0
Total	34.2	54.0	88.9	129.3

Distributed according to present industrial locations, by 2020 the industrial water requirements are expected to total 41.1 mgd in the Boise Service Area, 30.4 mgd in the Ontario-Payette Service Area, 2.3 mgd in the Snake River and Other Tributaries Subbasin, and 55.5 mgd in the Payette-Weiser Subbasin, including a 50.0 mgd demand for pulp and paper production near Weiser.

The primary industrial water uses in the two major service areas are for potato processing, sugar refining, and freezing and canning food products. Under present operating procedures, these industries reach a peak output during the fall and winter months and do not operate at all during much of the summer. Peak municipal requirements occur during the summer when industrial needs are minimal, suggesting that it may be advantageous to consolidate municipal and industrial systems in these areas.

Problems and Solutions

Except for small lumber operations near Baker and Halfway, Oregon, the subregion's industrial water demand is located over the extensive ground-water aquifer that extends from below Weiser to the foothills bordering Boise Valley. No problems are foreseen in water quantity, but poor quality (described under "Problems and Solutions" in the municipal section) could cause problems requiring special treatment before use.

Rural-Domestic

Basis for Water Supply Projections

Future water demand for domestic use in rural areas is based on an average annual per capita use figure applied to the projected rural population shown in table 59. Per capita domestic water use was assumed to be about 50 percent of that used in nearby municipalities at present. This per capita use figure was assumed to increase to 60 percent of that used in nearby communities in 1980, 70 percent of the municipal use in 2000, and 80 percent of the municipal use by 2020. Domestic water demand is expected to increase from 125 gpcd in 1965 to 165 gpcd by 1980, 205 gpcd by 2000, and 250 gpcd by 2020.

The livestock water component of the rural-domestic requirement was derived by applying present per animal water-use factors to the projected subregional large animal population presented in Appendix VI. Water use per animal is expected to remain constant over the projection period.

Projections of Water Supply Requirements

Anticipated rural-domestic water requirements are presented in table 62 by subbasin for the years 1970, 1980, 2000, and 2020. Total demand is expected to more than double by 2020. The 29.0 mgd present estimated usage is expected to increase to 53.0 mgd by 2020, with the growth fairly well distributed throughout the subregion. Approximately 38 percent of the projected 2020 rural-domestic use will be for domestic purposes.

Problems and Solutions

Most of the future rural-domestic needs are expected to be satisfied from ground-water sources. No widespread problems are foreseen in satisfying these requirements. Both quantity and quality could cause problems in some areas, however, and quality is a potential problem throughout the subregion. Disinfection of individual supplies could well be required in the near future in much of the subregion. Sound waste disposal practices to prevent ground-water contamination, coupled with careful location and design of water supply wells, would minimize problems associated with contamination of the supplies.

Table 62 - Projected Rural-Domestic Water Use, Subregion 5

	1970	1980	2000	2020
		MGD		
Payette-Weiser Subbasin				
Domestic	3.2	3.4	4.3	5.2
Livestock	3.2	4.0	5.3	6.9
	6.4	7.4	9.6	12.1
Boise Subbasin				
Domestic	7.2	7.1	6.9	6.0
Livestock	3.6	5.4	7.1	9.4
	10.8	12.5	14.0	15.4
Snake River and Other Tributaries Subbasin				
Domestic	5.1	5.5	7.0	8.7
Livestock	6.7	9.6	12.8	16.8
	11.8	15.1	19.8	25.5
Total				
Domestic	15.5	16.0	18.2	19.9
Livestock	13.5	19.0	25.2	33.1
	29.0	35.0	43.4	53.0

LOCATION MAP

SUBREGION 6

S U B R E G I O N 6

L O W E R S N A K E

INTRODUCTION

Subregion 6 consists of the drainage area of the lower Snake River located in southeastern Washington, northeastern Oregon, and central Idaho. The Northern Rocky Mountain terrain, occupying the southern and northeastern parts of the area, is generally mountainous with deep, narrow valleys. The Columbia Plateau, lying in the northwestern part of the subregion, includes river canyons, basalt plateaus, and the Palouse Hills.

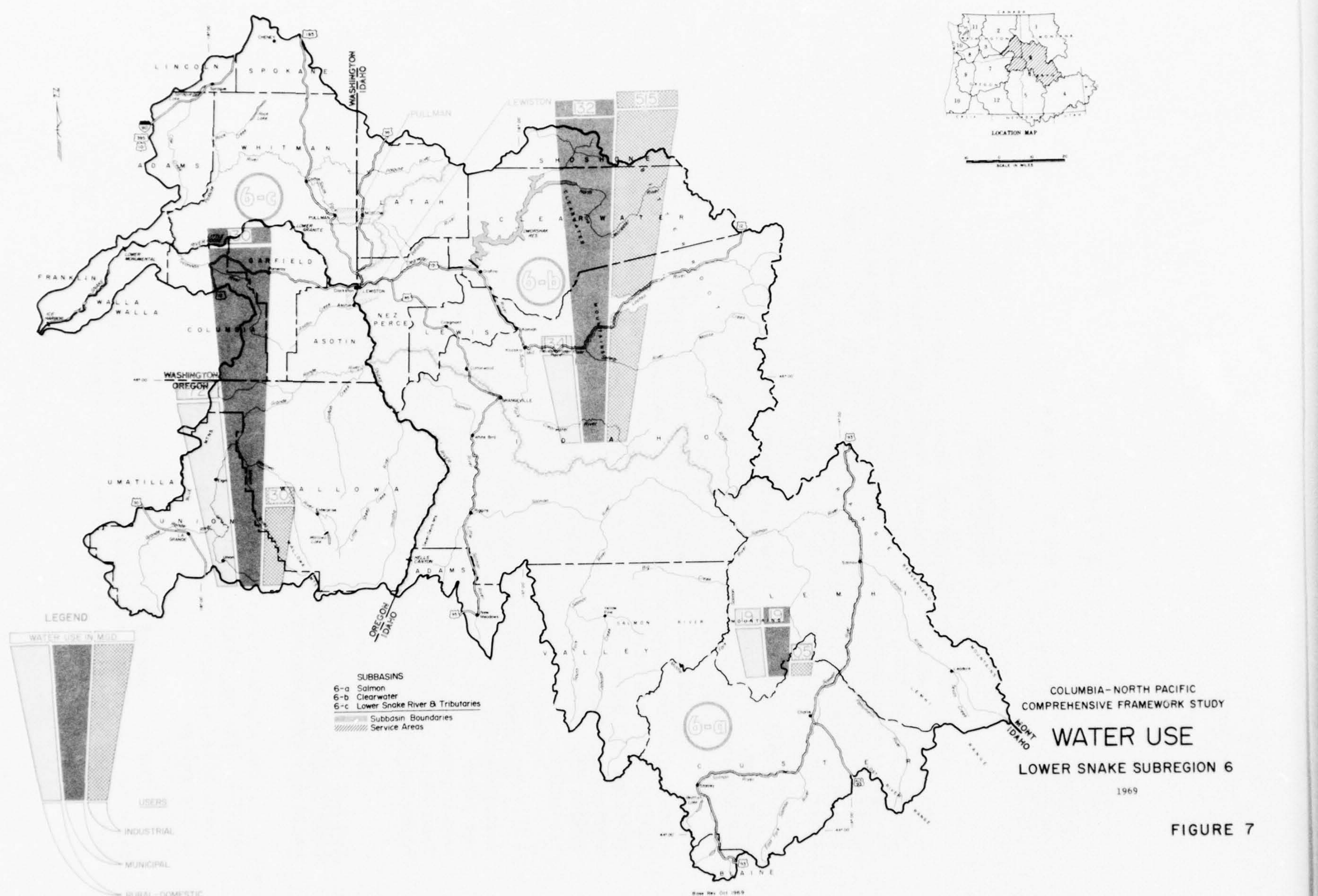
Topography has a strong influence on the climate of the subregion. The slopes of mountainous areas cause many different and distinct microclimates with wide variations in precipitation and temperature. The mountains are cool in summer and cold in winter. The lowlands are warm in summer and generally mild in winter with some extreme cold periods. Extremes of -44°F. to 109°F. have been recorded. The average frost-free growing season is about 150 days. Most of the precipitation falls during the winter, and summers are usually dry. Average annual precipitation ranges from about 7 to 60 inches, depending principally on the elevation.

The annual stream runoff varies from about one-half normal during dry years to one and three-fourths times normal during wet years. About 90 percent of the total runoff comes from melting snow at higher elevations. High flows generally occur from March through July as a result of snowmelt, and low flows occur normally from August through February.

The most important industries are forestry, agriculture, recreation-tourism, and mining. In recent years, more growth has been achieved in forestry, recreation-tourism, and food processing, while agricultural and mining employment has been declining.

The population in the Lower Snake Subregion is about 163,300. The population density averages less than 5 persons per square mile, compared with more than 20 persons per square mile in the region.

For purposes of this appendix, the subregion is divided in terms of significant subbasins and major service areas. The three major subbasins (figure 7) are the Salmon, Clearwater, and



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

WATER USE

LOWER SNAKE SUBREGION 6

1969

FIGURE 7

Lower Snake and Other Tributaries. The major service areas are the Lewiston and Pullman areas, which contain over two-fifths of the subregion's total population.

PRESENT STATUS

Table 63 is a summary of present municipal, major industrial, and rural-domestic water currently required in the subregion. At present, the water requirement averages about 95.6 mgd, including a municipal demand of 28.1 mgd, an industrial demand of 55.0 mgd, and a rural-domestic demand of 12.5 mgd. These needs are generally concentrated in the Lewiston Service Area; this area has a requirement of 56.7 mgd, of which 47.5 mgd are presently used by the pulp and paper industry.

Table 63 - Present Municipal, Major Industrial, and Rural-Domestic Water Supply Needs, Subregion 6

	Municipal	Industrial	Rural-Domestic	Total	% Total Subregion
	MGD				
Salmon Subbasin	1.9	0.5	1.9	4.3	4.5
Clearwater Subbasin					
Lewiston Serv. Area	9.2	47.5	-	56.7	59.3
Other	4.0	4.0	3.4	11.4	11.9
	13.2	51.5	3.4	68.1	71.2
Lower Snake and Other Tributaries Subbasin					
Pullman Serv. Area	5.7	0.3	0.3	6.3	6.6
Other	7.3	2.7	6.9	16.9	17.7
	13.0	3.0	7.2	23.2	24.3
Total	28.1	55.0	12.5	95.6	100.0

About 70 percent of the population is served by municipal water systems. Approximately 59 percent of the systems depend on ground-water sources, 22 percent on mixed supplies, and 19 percent on surface-water sources.

The pulp and paper industry requires about 97 percent of the total industrial requirement. Other industrial water uses are food processing and lumber and wood products.

Monthly demand data for municipal water use in the subregion and for industrial water use in the major water-use centers are summarized in table 64. Since no data are available concerning the municipal monthly pattern, a statistical analysis of water supply distribution for similar areas in the Pacific Northwest was used to derive the figures. Municipal water need is greatest from June through September. The maximum monthly requirement during this period is generally from 120 to 185 percent of the average monthly requirement. There is practically no seasonal variation for the forest products industry. The food-processing industry also shows little seasonal fluctuation, because the potato-processing water demand is high in the winter and low in the summer; and the canning and freezing water need is low in the winter and high in the summer.

Table 64 - Monthly Variation in Water Needs, Subregion 6

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	Percent											
Municipal	67	70	71	86	90	143	186	145	121	81	72	66
Industrial												
Lewiston Service Area												
Pulp and paper	100	100	100	100	100	100	100	100	100	100	100	100
Food processing	111	105	101	102	87	70	86	99	102	112	111	112
LaGrande area												
Wood and lumber products	100	100	100	100	100	100	100	100	100	100	100	100

Water Quality

Surface Water

With the exceptions of the Snake River and the tributaries draining the Columbia Plateau area, the surface waters are generally of adequate quality for most municipal and industrial purposes. The most common recurring quality problem is turbidity associated with periods of high runoff.

The mineral quality of most surface waters is good. The headwaters of the Grande Ronde and Salmon River systems are a calcium bicarbonate type with a dissolved solids concentration seldom exceeding 75 mg/l. However, the Pahsimeroi and Lemhi Rivers in the Salmon Subbasin flow through alluvial valleys and are more highly mineralized (200 to 300 mg/l dissolved solids). Some downstream mineralization occurs in the Grande Ronde and Salmon Rivers so that the dissolved solids level is about 100 mg/l when they enter the Snake River. The waters of the Clearwater River system are characterized by dissolved solids of only about 30 mg/l. The principal streams in the relatively flat Columbia Plateau are more highly mineralized. The Palouse and Tucannon Rivers average about 170 mg/l at their mouths. Objectionable

levels of troublesome trace constituents are seldom found in most surface waters of the subregion.

Sediment results in turbid conditions in many streams in Subregion 6. In late winter and spring, turbidity is particularly noticeable in the Palouse, Grande Ronde, and Tucannon Rivers and in Asotin Creek. Maximum concentrations of sediment observed in some streams have been 309,000 mg/l in Deadman Creek; 193,000 mg/l in the Tucannon River; 66,400 mg/l in the Palouse River; and 433 mg/l in the Clearwater River. In most cases, the turbidity during the high runoff period would necessitate the use of an auxiliary ground-water source or complete conventional treatment. Tailings from mining operations near Salmon, Idaho, have also resulted in turbidity problems in the Salmon River.

Bacterial contamination of waters is generally highly localized and does not place restrictions upon water use. However, the Snake River, the Palouse River system, and the Tucannon River consistently exhibit high coliform counts. (See Appendix XII for further details.)

With the exception of the Snake River, the streams in Subregion 6 generally do not have the prolific algal blooms that characterize waters in Subregions 4 and 5. The Lower Snake River generally experiences undesirable algal growths during August and September.

Ground Water

In general, the quality of ground water in the subregion is adequate for most municipal and industrial purposes. At present, there are no ground-water sources that require treatment, in addition to chlorination, to make the water a suitable supply.

The mineral quality of ground-water supplies for selected communities is listed in table 65. The mineral content of ground water is generally less than 300 mg/l. The waters are usually a calcium bicarbonate type and are soft to moderately hard. Iron, fluoride, and other trace constituents are usually not present in objectionable concentrations.

Treatment

A summary of municipal water sources and treatment practices is presented in table 66. Mineral removal and specialized treatment are not listed. Disinfection of ground water is not extensive,

Table 65 - Mineral Water Quality of Ground-Water Supplies, Subregion 6

	SiO_2	Fe	Ca	Mg	Na	HCO_3	SO_4	Cl	NO_3	Total Solids	Hard. $CaCO_3$	F	pH
	mg/l												
Cottonwood, Idaho	--	0.06	32	19	14	170	11	5	--	272	158	0.2	7.1
Craigmont, Idaho	--	0.00	34	10	25	164	6	5	--	262	124	0.5	7.1
Grangeville, Idaho (Well 2)	36	0.10	16	6	17	92	6	2	0.0	160	64	0.4	7.3
Kamiah, Idaho	--	0.02	14	6	10	74	7	0	--	130	61	0.2	7.3
Lewiston, Idaho	60	0.06	17	6	30	122	3	4	0.0	200	66	0.8	8.0
Moscow, Idaho	59	2.0	32	12	18	140	23	3	0.0	240	128	0.3	6.9
Potlatch, Idaho	--	0.05	11	4	53	148	6	3	--	226	46	0.1	8.3
Pullman, Wash. (Well 3)	--	0.39	22	15	22	196	0	4	0.2	238	118	0.2	7.7
Albion, Wash.	50	0.09	42	13	17	171	22	13	22	268	158	0.2	6.8
Colfax, Wash.	63	0.09	21	11	24	173	8	2	0.2	218	98	0.5	7.9
Pomeroy, Wash.	74	0.04	16	2	10	90	3	2	0.4	157	50	0.3	8.0
Enterprise, Oregon	12	0.3	44	2	7	117	14	0.4	--	164	130	0.0	7.9
LaGrande, Oregon (Well 2)	60	0.05	10	0.2	22	68	6	2	0.02	159	26	0.5	7.7
North Powder, Oregon	47	0.3	21	12	24	98	9	4	--	174	89	0.2	7.8

Table 66 - Summary of Municipal Water Sources and Treatment Practices, Subregion 6

Source	Number of Municipal Facilities	Population Served Thousands	Percent of Total Population
Surface			
No treatment	-	-	-
Disinfection	6	9.4	8.2
Complete	2	12.4	10.8
	8	21.8	19.0
Ground			
No treatment	33	45.9	40.0
Disinfection	6	21.8	19.0
Complete	-	-	-
	39	67.7	59.0
Mixed			
No treatment	1	0.4	0.4
Disinfection	2	9.8	8.5
Complete	1	15.0	13.1
	4	25.2	22.0
Total	51	114.7	100.0

with over three-fourths of the communities having no chlorination facilities. Of the communities relying on mixed or surface supplies, all but one provide at least chlorination; and three have complete conventional treatment (chemical coagulation, sedimentation, rapid sand filter, and chlorination) before distribution. One other community utilizing surface waters for an auxiliary supply provides sedimentation and filtration before use. In general, municipalities in the headwater areas of tributaries can utilize surface waters with only disinfection.

Salmon Subbasin

Municipal

Approximately 7,280 persons, or 65 percent of the Salmon Subbasin's population, are served by municipal water systems. The sparsely populated subbasin has an annual average municipal water requirement of only about 1.9 mgd.

The City of Salmon, which uses 1.2 mgd, has the largest municipal water requirement in the subbasin. The small towns of Challis, Cobalt, New Meadows, Riggins, and White Bird, are the only other communities with municipal water systems.

With the exception of Salmon and Challis, all communities depend entirely upon underground sources for water supplies. Salmon withdraws its supply from two small creeks, and Challis obtains its water chiefly from springs but utilizes a creek for an auxiliary supply.

Industrial

There are no data available concerning industrial water use in the Salmon Subbasin. The only significant water-using industries in the area are mining operations and scattered lumber mills. It is estimated that the lumber mills have an average water need of about 0.5 mgd. No water supply problems have been reported by these industries.

Rural-Domestic

The rural-domestic water requirement in the subbasin is approximately 1.9 mgd, including 0.5 mgd for domestic purposes and 1.4 mgd for livestock watering. In general, water for rural-domestic use is obtained from individual springs and wells or headwater areas of streams.

Clearwater Subbasin

Municipal

About 54,440 persons, or 81 percent of the subbasin's total population, are served by municipal water systems and have an annual average water requirement of 13.2 mgd. Most of this demand is centered in the Lewiston Service Area.

The Lewiston Service Area, which includes Lewiston, Clarkston, and Asotin, has an average municipal water requirement of about 9.2 mgd. The City of Lewiston derives most of its domestic water supply from the Clearwater River. Lewiston Orchards withdraws water from Sweetwater and Webb Creeks. Complete treatment, consisting of chemical coagulation, sedimentation, rapid sand filtration, and chlorination, is provided for both systems before distribution. Lewiston also supplements its supply with water obtained from wells. Ground water is the primary source of supply for Clarkston, its fringe area, and Asotin, Washington.

Outside of the Lewiston Service Area, the major municipal water use is in the communities of Grangeville, Orofino, Kamiah, and Cottonwood. These towns require 0.93, 0.69, 0.33, and 0.28 mgd, respectively. With the exception of Orofino, all of these communities depend entirely upon ground-water sources for supplies. Orofino withdraws its supply from the Clearwater River. Complete conventional treatment is provided before distribution.

Most other small towns scattered throughout the subbasin rely primarily upon underground sources for domestic water supplies. However, Elk River, Pierce, and Troy obtain part or all of their water supplies from surface sources.

Industrial

The industrial water requirement in the subbasin is 51.5 mgd, or nearly one-half of the total municipal, major industrial, and rural-domestic need for Subregion 6. The principal user is the pulp and paper industry, which requires 46.7 mgd. Minor industrial water uses include food processing and lumber and wood products manufacture.

All of the water demand by the pulp and paper industry occurs at Lewiston. The industry withdraws its supply from the Clearwater River. The Clearwater is also used to transport logs to the mill from upstream timber areas, and these are stored in the power pool of the Washington Water Power Company dam.

A number of lumber mills and a small plywood mill outside of the Lewiston Service Area have an estimated water need of 4.0 mgd. In addition, it is known that the lumber and wood products industry uses significant quantities of water for storing and moving logs.

Rural-Domestic

Approximately 3.4 mgd are required to satisfy the rural-domestic water demand in the Clearwater Subbasin. The rural population of about 13,460 persons has a need of about 1.6 mgd. Livestock watering has a requirement of 1.8 mgd.

In most cases, the rural-domestic water need is supplied by individual ground-water sources. In the headwater areas, surface-water sources are often utilized. In the Nez Perce and Camas Prairie areas, the unusual depth of the water table and the lack of deep well developments have resulted in an inadequate supply for stock and domestic purposes.

Lower Snake and Other Tributaries Subbasin

Municipal

Approximately 52,970 persons, or 62 percent of the population in this subbasin, are served by municipal water systems. The municipalities have an annual average requirement of 13.0 mgd. Most of this demand is centered in the Pullman Service Area and in the LaGrande area.

In the Pullman Service Area, the cities of Pullman and Moscow have average requirements of about 3.1 and 2.6 mgd, respectively. Both communities obtain domestic supplies from underground sources. Ground-water levels have been dropping steadily for over 25 years, however, and supplemental supplies are needed to meet present requirements.

The City of LaGrande has an average water need of about 2.3 mgd. The primary source of water for the LaGrande municipal system is Beaver Creek. Water is conveyed to the city by a 15.5-mile pipeline. During periods of high summertime demand, the surface-water supply is supplemented by water from artesian wells. Problems of taste, odor, and color, as well as storage and transmission limitations, have characterized the surface-water supply. Other communities in the Grande Ronde drainage area with significant municipal water needs are Elgin, Enterprise, Joseph, Union, and Wallowa, Oregon. The towns of Elgin and Enterprise obtain water from underground sources, while the remaining communities

utilize surface-water sources. Union, which withdraws its supply from Catherine Creek, experiences periodic turbidity problems.

All communities in the Palouse drainage area of the subbasin depend upon ground-water sources for supplies. In general, water is withdrawn from the Columbia River Group aquifer.

Industrial

Industrial water use in the subbasin is relatively small. The lumber industry at LaGrande is the largest single user, with an average need of about 1.0 mgd. Several other lumber mills in the subbasin have a combined water requirement of about 1.6 mgd. Other industrial water use is restricted to small packing plants and milk products plants.

Rural-Domestic

Approximately 7.2 mgd are necessary to satisfy the rural-domestic requirement. The rural population of about 32,230 persons has a water need of 4.1 mgd. Livestock watering in the subbasin has a requirement of 3.1 mgd.

The rural population generally relies upon individual water supplies drawn from ground-water sources. Livestock water is usually obtained from underground sources or small streams.

FUTURE NEEDS AND MEANS TO SATISFY NEEDS

At present, 29 percent of the 95.6 mgd municipal, industrial, and rural-domestic water need in Subregion 6 is used for municipal purposes, 58 percent is used by industries, and 13 percent is used for rural-domestic purposes. In the future, the need for municipal water supply is expected to grow faster than the demand for either industrial or rural-domestic supply. Industrial use will continue to dominate, however, utilizing 47 percent of the 182.4 mgd projected 2020 demand. By 2020, the municipal need will increase to 39 percent of the total requirement, and the rural-domestic need will remain fairly constant at 14 percent. Total demands are expected to almost double by 2020.

The estimated population of 163,000 in 1965 is projected to increase to 274,000 by 2020. This represents an increase of only 68 percent, compared with a regional increase of 121 percent. Table 67 shows projected population growth by subbasin and service area for 1980, 2000, and 2020. By 2020, 57 percent of the

subbasin's population will be concentrated in the Lewiston and Pullman Service Areas. Only 16 percent of the population will reside in rural areas.

Production of the major water-using industries is projected to increase by more than 58 percent between now and 2020 in terms of dollar value. It is anticipated that lumber and wood products will continue to be the major industry between now and 2020.

Municipal

Basis for Water Supply Projections

The projected population to be served by municipal water systems in 1980, 2000, and 2020 is shown in table 67. It is anticipated that by 2020 about 84 percent of the population will be served by central systems. Projected municipal water requirements are based on population estimates shown in table 67 and on per capita water needs presented in the "Future Needs" section of the Regional Summary. Average demands for the subregion are expected to increase from 255 gpcd in 1965 to 275 gpcd in 1980, 295 gpcd in 2000, and 310 gpcd in 2020.

Projections of Water Supply Requirements

Projected municipal water requirements for the years 1970, 1980, 2000, and 2020 are shown in table 68 by subbasin and service area. By 2020, about 67 percent of the subregion's municipal water need is expected to occur in the Lewiston and Pullman Service Areas. The balance of the demand will be scattered throughout the subregion, with the towns of LaGrande, Oregon; Grangeville, Idaho; and Colfax, Washington, requiring significant amounts. All persons within the major service areas will be served by public water systems by the end of the projection period. At that time, 48.4 mgd will be required in these two service areas, 7.6 mgd will be required by other municipalities in the Clearwater Subbasin, 12.1 mgd will be required by other communities in the Lower Snake and Other Tributaries Subbasin, and 3.9 mgd will be required in the Salmon Subbasin.

Table 67 - Projected Population, Subregion 6

	1980	2000	2020
	---------Thousands----------		
Salmon Subbasin	13.0	15.0	16.5
Municipal	9.0	11.0	12.5
Rural	4.0	4.0	4.0
Clearwater Subbasin	86.8	115.6	147.1
Lewiston Service Area	54.8	82.0	112.6
Municipal	54.8	82.0	112.6
Rural	--	--	--
Other	32.0	33.6	34.5
Municipal	19.0	21.3	24.0
Rural	13.0	12.3	10.5
Subtotal	86.8	115.6	147.1
Municipal	73.8	103.3	136.6
Rural	13.0	12.3	10.5
Lower Snake & Other Tributaries Subbasin	93.7	104.0	110.7
Pullman Service Area	30.5	38.0	43.4
Municipal	30.5	38.0	43.4
Rural	--	--	--
Other	63.2	66.0	67.3
Municipal	32.0	36.0	39.1
Rural	31.2	30.0	28.2
Subtotal	93.7	104.0	110.7
Municipal	62.5	74.0	82.5
Rural	31.2	30.0	28.2
Total Subregion	193.5	234.6	274.3
Municipal	145.3	188.3	231.6
Rural	48.2	46.3	42.7

Table 68 - Projected Municipal Water Use, Subregion 6

	1970	1980	2000	2020
	MGD			
Salmon Subbasin	2.1	2.5	3.3	3.9
Clearwater Subbasin				
Lewiston Service Area	11.0	14.6	24.2	34.9
Other	4.4	5.3	6.4	7.6
	15.4	19.9	30.6	42.5
Lower Snake and Other Tributaries Subbasin				
Pullman Service Area	6.4	7.9	10.9	13.5
Other	7.8	8.7	10.6	12.1
	14.2	16.6	21.5	25.6
Total	31.7	39.0	55.4	72.0

Problems and Solutions

Most existing water supply sources are considered adequate to meet future demands. It is expected that in the future all supplies will be provided at least disinfection and that most surface supplies will require complete treatment. Areas where quantity and/or quality problems are expected to interfere with development of supplies to meet future requirements are discussed below by subbasin.

Salmon Subbasin The small creeks used by the cities of Salmon and Challis at present may not have firm yields large enough to meet 2020 demands. Salmon River water is an alternative source of supply that would meet future quantity needs. Quality would likely be a problem, however, and it is assumed that complete conventional treatment would be required.

With proper location and design of water supply wells, the other smaller communities in the subbasin should be able to expand the source of their existing supplies to meet future needs.

Clearwater Subbasin No serious quality or quantity problems are foreseen in meeting needs in this subbasin. Localized problems, both in quality and quantity, have occurred in the past, particularly in the Lewiston Service Area, but these have been resolved. It is expected that most existing water sources can be utilized to meet future requirements.

Unappropriated base flows of the Clearwater River are many times larger than the total 2020 water supply demand for the subbasin and could be used to replace or supplement supplies for communities now using wells in areas subject to ground-water depletions.

Lower Snake and Other Tributaries Subbasin The cities in the Pullman Service Area obtain supplies from a ground-water table that has been steadily dropping for several years, indicating that withdrawals have been exceeding the recharge. Supplemental supplies are needed to meet present needs. More water is a "must" if the area is to accommodate its projected population growth.

The cities of Moscow, Idaho, and Pullman, Washington, have been studying sources of supplemental water for some time, and several schemes have been considered. The most likely means of satisfying future requirements is to build a storage reservoir in the headwaters of the North Fork Palouse, pump over the hill to a point between the two cities, provide complete conventional treatment to the joint supply, and distribute the water to the two towns. Alternative sources that have been considered are the South Palouse River, the Snake River, and the Potlatch River.

Both quantity and quality problems have been encountered in meeting water supply needs in the Grande Ronde drainage in the past. Additional development of surface supplies is necessary to meet future needs. Because of taste, odor, and color problems that have occurred when using these sources in the past, it is likely that special treatment will be required to provide water suitable for municipal use.

The authorized Corps of Engineers' Grande Ronde and Catherine Creek Dam and Reservoir projects include water supply storage for the towns of LaGrande and Union, Oregon. Detailed planning on Catherine Creek Reservoir is now in progress.

Industrial

Basis for Water Supply Projections

Projected industrial water supply needs are based are growth indices derived from data presented in Appendix VI and on present water use for each industrial category. Water use per unit of product was assumed to remain unchanged for purposes of estimating future requirements.

Projections of Water Supply Requirements

Table 69 shows the projected water demands to 2020 by industrial category. The pulp and paper industry, located in the Lewiston Service Area, is the largest user at present and will continue to dominate throughout the projection period. Food-processing and lumber and wood products industries use relatively small amounts of water at present. Very little growth is projected for these categories.

Table 69 - Projected Industrial Water Use, Subregion 6

	1970	1980	2000	2020
	MGD			
Pulp and paper	49.9	56.5	64.4	72.9
Food products	1.7	2.6	3.6	3.9
Lumber and wood products	7.5	8.3	9.1	8.6
Total	59.1	67.4	77.1	85.4

It is assumed that most industrial growth will occur in the vicinity of existing operations. Based on that assumption, all of the subregion's future water requirement for pulp and paper production and two-thirds of the demand for food processing will occur in the Lewiston Service Area. The water requirement for lumber and wood products operations will be scattered throughout the region, with over half of the need occurring in the Clearwater Subbasin. Distributed according to present locations, industrial water needs by 2020 are expected to total 0.6 mgd in the Salmon Subbasin, 4.5 mgd in the Lower Snake and Other Tributaries Subbasin, and 80.3 mgd in the Clearwater Subbasin. About 94 percent of the 2020 demand in the Clearwater Subbasin will occur in the Lewiston Service Area.

Problems and Solutions

Over 88 percent of the total 2020 industrial water requirements for the subregion are expected to occur in the Lewiston Service Area, where ample supplies are available from the Clearwater River. Some local problems in meeting future needs in other portions of the subregion could arise, however. The types of

problems to be expected and suggested solutions were discussed previously in the section on Municipal Water, Problems and Solutions.

Rural-Domestic

Basis for Water Supply Projections

The future water requirement for domestic use in rural areas is based on an average annual per capita use figure applied to the projected rural population shown in table 67. Per capita domestic water use was assumed to be about 50 percent of that used in nearby municipalities at present. This per capita use figure was assumed to increase to 60 percent of that used in nearby communities in 1980, 70 percent of the municipal use in 2000, and 80 percent of the municipal use by 2020. Domestic water demand is expected to increase from 125 gpcd in 1965 to 165 gpcd by 1980, 205 gpcd by 2000, and 250 gpcd by 2020.

The livestock water component of the rural-domestic demand was derived by applying present per animal water-use factors to the projected subregional large animal population presented in Appendix VI. Water use per animal is expected to remain constant over the projection period.

Projections of Water Supply Requirements

Anticipated rural-domestic water requirements are presented in table 70 by subbasin for the years 1970, 1980, 2000, and 2020. Total demand is expected to double by 2020. The 13.8 mgd present estimated usage is expected to increase to 25.0 mgd by 2020, with the growth fairly well distributed throughout the subregion. Approximately 42 percent of the projected 2020 total municipal and industrial need will be for domestic purposes.

Problems and Solutions

Most future rural-domestic needs are expected to be satisfied from ground-water sources, and no widespread problems are foreseen in satisfying these needs. Both quantity and quality could cause problems in some areas, however, and quality is a potential problem throughout the subregion. Disinfection of individual supplies could well be required in the near future in much of the subregion. Sound waste disposal practices to prevent ground-water contamination, coupled with careful location and design of water supply wells, would minimize the need to treat individual supplies.

Table 70 - Projected Rural-Domestic Water Use, Subregion 6

	1970	1980	2000	2020
	MGD			
Salmon Subbasin				
Domestic	0.6	0.7	0.8	1.0
Livestock	1.5	1.8	2.5	3.2
	2.1	2.5	3.3	4.2
Clearwater Subbasin				
Domestic	1.8	2.1	2.5	2.6
Livestock	2.0	2.4	3.2	4.1
	3.8	4.5	5.7	6.7
Lower Snake and Other Tributaries Subbasin				
Domestic	4.4	5.1	6.2	7.0
Livestock	3.5	4.1	5.4	7.1
	7.9	9.2	11.6	14.1
Total				
Domestic	6.8	7.9	9.5	10.6
Livestock	7.0	8.3	11.1	14.4
	13.8	16.2	20.6	25.0

LOCATION MAP

SUBREGION 7

SUBREGION 7 - MID-COLUMBIA

INTRODUCTION

Subregion 7 includes the area drained by streams flowing into the Columbia between the Snake on the east and Bonneville Dam on the west. The area contains 29,606 square miles in the states of Oregon and Washington. The subregion is surrounded by mountains--the Cascades on the west, the Ochocos on the south, the Blue Mountains on the east, and the Horse Heaven Hills on the north. Elevations range from over 10,000 feet in the Cascade Range to near sea level at Bonneville Dam. There are no extensive areas of flatland, although there are many broad valleys and rolling hills.

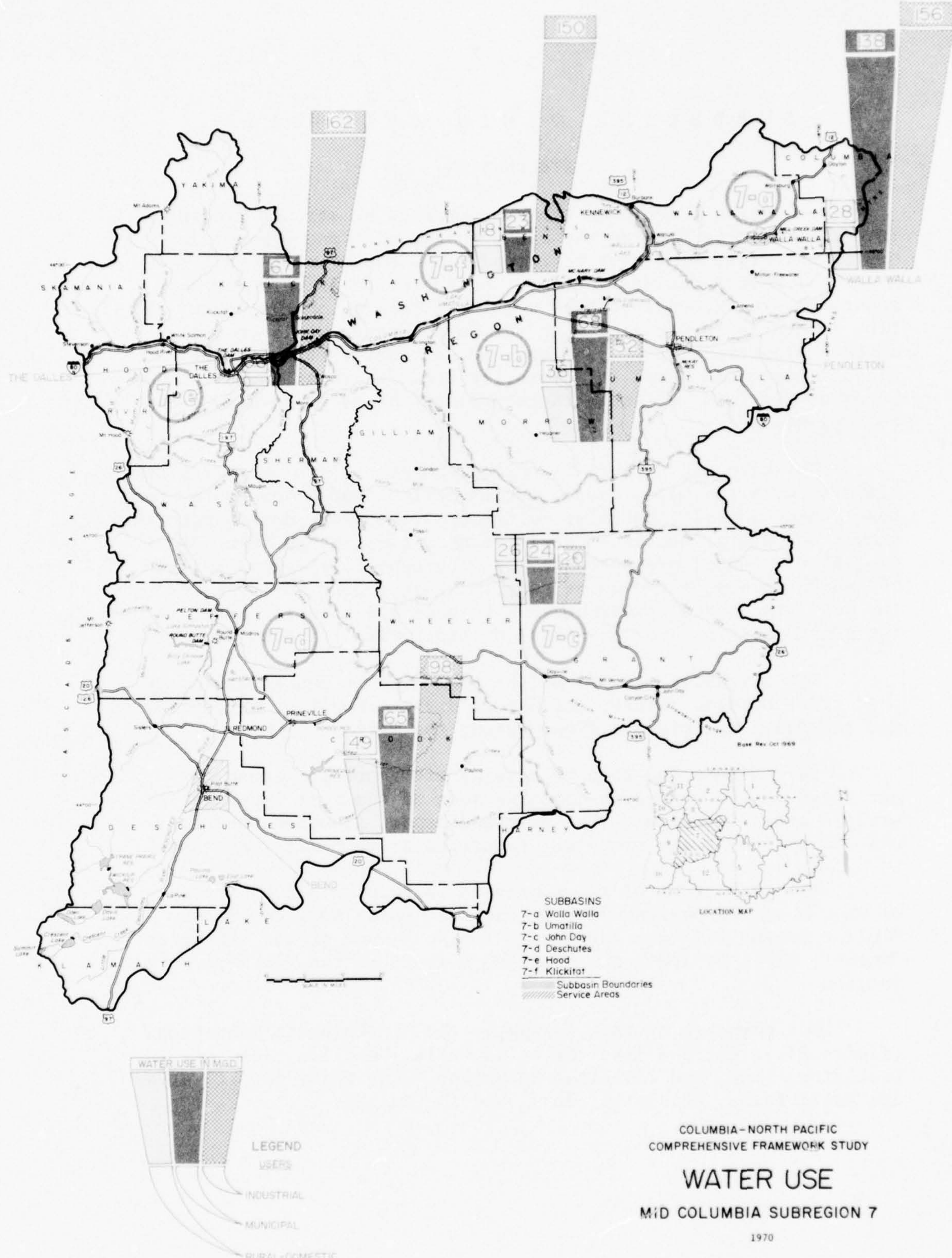
The climatic pattern is one of cool-to-cold winters and hot summers, with the major precipitation period from November to April. Yearly and diurnal temperature extremes are common, during both the summer and winter months. Extreme temperatures range from -33° F. to 115° F. Annual average precipitation generally ranges between 10 and 20 inches, although at some locations along the Cascades on the west, the annual precipitation is over 130 inches. Also, in the Blue Mountains average annual precipitation is about 40 inches.

The discharge pattern of the subregion is characterized by peak flows between January and May (a direct result of precipitation and snowmelt) and minimum flows during the fall.

Agriculture and food processing are important economic activities. The subregion contains some of the most important orchard areas in Oregon. The pulp and paper, aluminum, textile, and lumber industries are also of particular economic importance.

The population of the subregion is about 210,300 persons, of whom about 39 percent live in the four major service areas. Smaller communities are numerous throughout much of the subregion. However, areas of low population predominate in the southern section.

For purposes of this appendix, the Mid-Columbia Subregion (figure 8) is divided into the Walla Walla, Umatilla, John Day, Deschutes, Hood, and Klickitat Subbasins. The major service areas are Walla Walla, Pendleton, Bend, and The Dalles.



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

WATER USE

MID COLUMBIA SUBREGION 7

1970

FIGURE 8

PRESENT STATUS

Table 71 summarizes the water use in each of the subbasins. At present, the water requirement averages about 118.6 mgd, including a municipal demand of 38.5 mgd, an industrial demand of 63.8 mgd, and a rural-domestic demand of 16.3 mgd. The four service areas account for about 51 percent of the average municipal need. The major industrial water users are generally located outside of the principal service areas. The average industrial need within the service area, is only 27 percent of the total.

Table 71 - Present Municipal, Major Industrial, and Rural-Domestic Water Supply Needs, Subregion 7

	Municipal	Industrial	Rural-Domestic	Total	% Total Subregion
	MGD				
Walla Walla Subbasin					
Walla Walla Service Area	10.1	3.0	0.3	13.4	11.3
Other	3.7	12.6	2.5	18.8	15.9
	13.8	15.6	2.8	32.2	27.2
Umatilla Subbasin					
Pendleton Serv. Area	3.6	0.9	-	4.5	3.7
Other	3.2	4.3	3.6	11.1	9.4
	6.8	5.2	3.6	15.6	13.1
John Day Subbasin	2.4	2.0	2.6	7.0	5.9
Deschutes Subbasin					
Bend Service Area	3.3	5.6	0.3	9.2	7.8
Other	3.2	4.2	4.6	12.0	10.1
	6.5	9.8	4.9	21.2	17.9
Hood Subbasin					
The Dalles Service Area	2.8	7.5	0.3	10.6	8.9
Other	3.9	8.7	0.3	12.9	10.9
	6.7	16.2	0.6	23.5	19.8
Klickitat Subbasin	2.3	15.0	1.8	19.1	16.1
Total	38.5	63.8	16.3	118.6	100.0

About 66 percent of the population is served by municipal water systems. Approximately 37 percent of the systems depend primarily on ground-water sources, 19 percent on surface-water sources, and 44 percent on mixed supplies.

The principal industrial water users are the food-processing and forest products industries. These industries require about 10.2 mgd and 47.5 mgd, respectively.

Table 72 presents the monthly variation in demand for the major water-use categories in each of the service areas. The municipal monthly pattern for the Walla Walla Service Area is based on actual records. Since no data are available concerning the monthly municipal pattern in the Pendleton, Bend and The Dalles Service Areas, a statistical analysis of water supply distribution for similar areas in the Pacific Northwest was used to derive the figures. The peak municipal water use occurs during the period from June through September, with July the month of maximum need. With the exception of food processing, the industrial water use shows little seasonal variation.

Table 72 - Monthly Variation in Water Needs, Subregion 7

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	Percent											
Walla Walla Service Area												
Municipal	77	79	86	74	72	137	178	147	114	84	77	74
Food products	34	31	34	65	116	161	214	120	114	126	90	94
Pendleton Service Area												
Municipal	67	70	71	86	90	143	186	145	121	81	72	66
Food products	22	15	19	24	20	253	428	249	72	41	29	28
Lumber & wood products	126	129	103	129	76	107	103	90	113	86	71	67
Manufacturing	71	85	90	107	101	107	112	101	118	112	99	96
Bend Service Area												
Municipal	67	70	71	86	90	143	186	145	121	81	72	66
Lumber & wood products	100	100	100	100	100	100	100	100	100	100	100	100
The Dalles Service Area												
Municipal	67	70	71	86	90	143	186	145	121	81	72	66
Food products 1/												
Primary metals	100	100	100	100	100	100	100	100	100	100	100	100

1/ No data available.

Water Quality

Surface Water

Generally, the surface waters available for municipal and industrial purposes are of excellent quality. The only exceptions are the usual local bacterial contamination below municipalities and excessive turbidity and vegetative color during periods of high runoff. The surface waters would be suitable for most domestic and industrial uses with varying degrees of treatment. Many streams--especially the Walla Walla, Crooked, Umatilla, and John Day Rivers--would require treatment for color, turbidity, and silica removal.

The mineral character of the streams in the subregion reflects the arid climate and the use of water for irrigation. In the upper reaches, the streams are a calcium-magnesium bicarbonate type and are low in dissolved solids. The availability of natural soluble minerals in areas which are irrigated, and sometimes spring inflow, contribute to downstream increases in mineralization as the streams flow through the arid parts of the subregion. Where irrigation return flows are significant, the percent of sodium cation usually increases. The Walla Walla, John Day, and Umatilla Rivers show the greatest range in dissolved solids content. Irrigation use is much less extensive in the Klickitat and White Salmon River systems. Also, the streams flow through less arid plateau areas. Consequently, their average dissolved solids content at the mouth is considerably less. The Columbia River at McNary Dam contains calcium-magnesium bicarbonate water with an average dissolved solids concentration of 109 mg/1. Downstream at The Dalles Dam below all major tributaries which enter this subregion, the average dissolved solids concentration is 114 mg/1. Quality data of surface water are listed in table 73.

Many streams in Subregion 7 carry large amounts of suspended sediment and are often very turbid during high runoff periods. The maximum observed concentration has been 316,000 mg/1 on Dry Creek, a tributary of the Walla Walla River. The highest concentrations observed in all streams occurred during the flood of December 1964; however, sediment transport is high during any flood period.

Dissolved oxygen levels in the streams are normally satisfactory and present no water quality problems, except in one area. In the Walla Walla Subbasin, seasonal discharges of inadequately treated industrial wastes, coupled with low flows resulting from irrigation diversions, result in depletion of oxygen to nearly septic conditions in Mill Creek and the lower Walla Walla River. Below the treatment plant and downstream near Touchet, coliform levels are high, rendering the streams unsuitable for most uses. Coliform values up to 150,000 organisms/100 ml have been recorded.

High bacterial densities have been found below other population concentrations throughout the subregion, such as the upper reaches of the John Day. High counts have also been found on occasion in unpopulated areas, indicating that soil bacteria and animal populations can have a decided effect on the indicated levels of coliform bacteria.

Ground Water

The mineral quality of ground-water supplies for selected communities is listed in table 74. The ground water is usually of

Table 73 - Summary of Water Quality Data for Surface Water, Subregion 7

	River Mile	D.O. (mg/l)	(°C)	Coliform MPN/100ml	pH	Color (PT-CO) Units	Hard. (mg/l)	Turb. (JTU)	TDS (mg/l)	Ortho PO_4 (mg/l)	NO_3-N (mg/l)
Walla Walla River	313.5-13.0										
Mean		10.6	13.3	5,524	7.6	8	110	59	207	0.38	0.46
Min.		8.2	1.8	230	7.0	5	30	5	78	0.21	0.11
Max.		14.5	25.0	46,000	8.5	35	318	300	569	0.80	1.04
Touchet River	313.5-16.4-53.2										
Mean		11.1	8.4	72,280	7.5	10.4	29	--	76	0.10	0.07
Min.		9.1	0.0	0	7.0	5.0	21	--	66	0.00	0.02
Max.		12.7	20.5	460,000	8.3	25.0	34	--	86	0.23	0.16
Umatilla River	288.8-57.1										
Mean		10.3	10.7	266	7.9	9	32	6	100	0.15	0.06
Min.		7.9	4.0	13	7.2	3	20	1	77	0.03	0.01
Max.		13.2	28.0	2,400	9.0	22	39	16	133	0.44	0.15
Umatilla River	288.8-48.0										
Mean		10.8	12.4	21,520	7.9	22	41	7	133	0.55	0.30
Min.		8.2	2.5	450	7.0	7	25	4	101	0.18	0.02
Max.		13.7	23.0	70,000	8.4	50	53	12	209	1.16	0.55
Umatilla River	288.8-2.2										
Mean		11.7	14.0	1,886	8.2	9	129	5	270	0.28	0.57
Min.		9.3	4.0	45	7.1	0	31	0	119	0.01	0.02
Max.		16.0	25.0	7,000	8.9	25	232	48	1,110	0.60	1.32
John Day River	218-247.1										
Mean		9.7	11.2	5,335	8.1	14	113	10	225	0.46	0.20
Min.		3.3	4.0	230	7.4	4	87	1	153	0.16	0.01
Max.		13.1	22.5	70,000	8.8	28	150	45	392	0.85	0.56
John Day River	218-21.0										
Mean		10.9	12.3	422	8.1	10	--	19	247	0.10	0.08
Min.		7.2	1.0	21	7.5	1	--	0	119	0.01	0.01
Max.		14.4	25.0	7,000	8.9	27	--	80	1,200	1.12	0.38
Deschutes River	204.1-168.8										
Mean		10.0	10.4	115	7.5	5	21	5	88	0.16	0.04
Min.		8.1	3.0	5	7.1	0	4	0	51	0.04	0.01
Max.		12.3	18.0	500	8.0	15	30	18	158	0.54	0.19
Deschutes River	204.1-133.4										
Mean		10.7	12.3	133	7.9	7	27	4	84	0.11	0.07
Min.		7.1	0.5	4	6.9	0	1	0	9	0.00	0.01
Max.		13.3	25.0	620	9.5	14	47	11	244	0.24	0.21
Crooked River	204.1-113.8-3.3										
Mean		10.2	12.1	165	8.0	4	56	5	147	0.19	0.12
Min.		9.0	2.0	23	7.4	0	3	0	61	0.00	0.01
Max.		12.0	19.5	700	9.4	10	74	20	253	0.91	0.42
Metolius River	204.1-111.3-10.7										
Mean		11.0	10.5	111	7.6	4	34	5	107	0.14	0.05
Min.		8.9	5.0	6	7.2	0	2	0	62	0.01	0.01
Max.		12.7	25.0	700	9.2	13	62	14	170	0.64	0.19
Deschutes River	204.1-96.8										
Mean		11.2	11.3	345	7.9	6	41	5	112	0.18	0.09
Min.		9.2	2.0	23	7.3	0	3	0	9	0.07	0.01
Max.		13.5	17.0	2,400	9.9	11	50	16	164	0.60	0.22
Deschutes River	204.1-1.0										
Mean		11.2	11.6	345	8.1	6	41	5	112	0.18	0.09
Min.		9.2	5.0	23	7.6	0	3	0	9	0.07	0.01
Max.		12.7	19.0	2,400	8.4	11	50	16	164	0.60	0.22
White Salmon River	168.3-2.0										
Mean		--	--	--	7.4	5	22	1	60	0.09	0.05
Min.		--	--	--	7.0	0	17	0	43	0.04	0.00
Max.		--	--	--	7.7	15	25	5	75	0.21	0.18

good chemical and physical character, and generally contains dissolved solids ranging from 200 to 500 mg/1; bicarbonate as the predominant anion; calcium or sodium as the chief cation; water moderately hard to hard, although it may be very hard in some geological formations; fluorides and boron below recommended levels; and temperatures ranging from 50°F. to 75°F.

Table 74 - Mineral Water Quality of Ground-Water Supplies, Subregion 7

	SiO_2	Fe	Ca	Mg	Na	HCO_3	SO_4	Cl	NO_3	Total Solids	Hard. $CaCO_3$	F	pH
	mg/l												
Athena, Ore. 5/18/54	50	0.07	18	8.8	37	142	24	3.7	--	239	73	0.7	8.3
Boardman, Ore. 10/12/55	--	0.07	1.7	-	16	176	58	37	--	379	84	-	8.2
Canyon City, Ore. 4/13/54	10	0.1	9.5	20	3.4	103	3.3	1.1	--	122	102	0.0	8.2
Condon, Ore. 9/10/60	35	13.3	55	28.6	20	202	30	28	0.05	422	256	0.5	7.2
Deschutes Valley W.D., Ore. 2/11/55	45	0.05	8.8	8.9	25	70	4.3	5.9	--	136	50	0.4	7.9
Fossil, Ore.	--	0.45	4.2	1.0	120	268	23	19.1	0.15	423	15	5.5	9.0
Hermiston, Ore. (Well 1) 7/12/61	59	0.03	23.3	8.9	50.5	145	61.7	11.0	0.00	354	95	0.6	8.2
John Day, Ore. 5/13/60	--	0.06	14.8	28.2	15	156	14.9	2.7	1.5	210	152	0.3	8.0
Madras, Ore. 6/15/60	45	0.05	29.0	7.3	69	153	18.2	12.1	0.6	276	103	0.2	7.6
Milton-Freewater, Ore. 11/6/60	45	0.08	17.2	9.9	6.1	85	10.4	8.0	0.4	153	84	0.3	8.0
Monument, Ore. 5/13/60	--	0.05	23.4	6.9	17.2	83	130	5.8	0.4	191	87	0.2	7.1
Pendleton, Ore. 6/24/54	42	0.37	26	18	60	129	20	33	--	300	99	0.4	8.2
Spray, Ore. 4/3/61	38	0.00	31.5	32.6	94.5	253	20.2	19.7	4.2	447	212	0.2	8.9
Stanfield, Ore. 2/2/54	42	0.4	48	8.4	29	300	34	10.5	--	448	190	0.7	7.8
Walla Walla, Wn. (Well 5) 7/29/60	62	0.06	16	5.3	29	148	5.0	3.0	0.1	200	62	1.0	8.2

Bacterial contamination exists in or threatens many shallow wells, particularly in Umatilla County. Deep wells in the Milton-Freewater area are also in danger of contamination because of faulting and jointing in the basalt. Concern has been expressed about the disposal of municipal and industrial wastes in lava sinkholes in the Bend area. Studies are now under way to determine if these wastes reach the ground-water aquifers being used downstream.

Treatment

Table 75 summarizes water treatment practices by communities in the subregion. Mineral removal and specialized treatment are not listed. All surface-water and mixed supplies receive at least disinfection before distribution, but most municipalities utilizing ground water provide no treatment.

Table 75 - Summary of Municipal Water Sources and Treatment Practices, Subregion 7

Source	Number of Municipal Facilities	Population Served Thousands	Percent Total Population
Surface			
No treatment	1	0.5	0.4
Disinfection	5	15.8	11.2
Complete	3	10.1	7.1
	9	26.4	18.7
Ground			
No treatment	34	38.7	27.4
Disinfection	12	13.9	9.8
Complete	-	-	-
	46	52.6	37.2
Mixed			
No treatment	2	0.8	0.6
Disinfection	4	44.9	31.7
Complete	3	16.7	11.8
	9	62.4	44.1
Total	64	141.4	100.0

Walla Walla Subbasin

Municipal

Approximately 41,390 persons, or 71 percent of the population of the Walla Walla Subbasin, are served by municipal water systems. Municipalities have an average water requirement of 13.8 mgd.

The Walla Walla Service Area, including the communities of Walla Walla and College Place, is the major municipal water user in the subbasin. Nearly three-fourths of the subbasin's average municipal demand is used in this area. The city of Walla Walla utilizes surface water from Mill Creek and ground water from the Columbia River basalt aquifer. Adequacy of the existing facilities is questionable due to a limitation on surface-water diversion and over-pumping of several wells. The city of College Place utilizes two artesian wells for its water supply.

Other major communities in the subbasin are Milton-Freewater and Weston, Oregon; and Prescott, Waitsburg, and Dayton, Washington. These communities contain about 17 percent of the subbasin's total population and 24 percent of the municipal population. Dayton and Waitsburg obtain most of their water from surface sources but have auxiliary ground-water supplies. The remainder of the communities rely principally on ground water. The city of Dayton experiences shortages of water during summer months as present needs exceed firm surface-water rights.

The communities of Walla Walla, Milton-Freewater, and Dayton have exceptionally high average per capita consumption, ranging from 330 gpcd for Walla Walla and Dayton to 460 gpcd for Milton-Freewater. At least part of this high demand is attributed to losses in the systems and/or water consumed by non-metered users.

It has been recommended by local health officials that water from shallow wells should not be used for domestic purposes without proper disinfection. Surveys have disclosed bacteriological contamination of the shallow wells along Dry Creek northwest of Milton-Freewater. Also, individual samples over a period of years indicate most shallow wells in the subbasin are either contaminated or in danger of contamination. The sources of contamination are judged to be feedlots, barnyards, septic tanks, etc.

Because of faulting and jointing characteristics of the Columbia River basalt, it has been recommended that water from deep wells in the area should also be disinfected before domestic use.

Industrial

Industries in the subbasin have an annual average water requirement of 15.6 mgd. The food-processing industry utilizes 6.6 mgd, and the pulp and paper industry at Wallula needs about 9.0 mgd. The food-processing industry usually depends upon municipal facilities for water supplies, although several firms have developed independent ground-water sources to provide for supplemental needs. The pulp mill has developed an independent supply.

The food-processing industry is characterized by high water needs during the period from June to September. Although no monthly water usage data are available for the pulp mill, use is assumed to be relatively constant.

Small lumber mills and logging operations also exert an additional water demand, the relative extent of which is not known at present.

Rural-Domestic

Approximately 16,510 persons, or 29 percent of the subbasin's total population, are classed as rural. Domestic water needs and stock-watering requirements are about 2.1 and 0.7 mgd, respectively. Water is usually obtained from springs or wells and is of good quality and of sufficient quantity for most purposes. However, in the Milton-Freewater area, shallow wells have been threatened by bacterial contamination and by water shortages during the non-irrigating seasons.

Umatilla Subbasin

Municipal

Municipal water systems serve approximately 27,920 persons, or about 68 percent of the subbasin's population. The major municipal water use is centered in the Pendleton Service Area, which utilizes over one-half of the subbasin's total municipal demand of 6.8 mgd. With the exception of Pendleton, all municipal systems depend on wells drawing principally from Columbia River basalts. Pendleton's primary source is Thornhallow Springs, but its supply is supplemented by wells during low-flow periods. The springs are situated along the Umatilla River and become so turbid during flood stages that the city uses the wells as a supplement.

Ground water in the subbasin is generally of good quality. However, Hermiston provides aeration equipment to remove excessive amounts of hydrogen sulfide found in well waters.

Industrial

The major industrial water users are the food-processing and lumber-manufacturing concerns. These industries utilize water at the rate of about 0.8 and 3.7 mgd, respectively.

The Pendleton Service Area is the industrial center of the subbasin, supporting food-processing plants, a woolen mill, and a wood products plant. About 0.9 million gallons of water are used daily by industries. The Pendleton municipal water facility is generally utilized by the industries.

The major industrial use of water for lumber manufacturing occurs in the Pilot Rock area. Present use is approximately 3.5 mgd. Independent ground- and surface-water supplies have been developed for these industries. Little seasonal fluctuation in the water requirement can be expected. Other logging and lumber

operations throughout the subbasin have a combined water use of about 0.6 mgd.

Rural-Domestic

Approximately 12,780 persons, or 32 percent of the subbasin's total population, are served by individual water systems. About 1.6 mgd are used by this portion of the population. Most of the rural population depend primarily on ground water for their supplies. A majority of the domestic wells draw from alluvial and other sedimentary deposits. The wells are generally less than 100 feet deep and produce sufficient quantities of water.

It is estimated that stock watering requires about 2.0 mgd. Water for stock use is generally obtained from shallow wells or streams.

Seasonal domestic well-water shortages have occurred in the Willow Creek and lower Butter Creek drainages due to the increase in the number of wells and resultant withdrawals in excess of recharge.

The quality of water in the sedimentary deposits is generally free of high mineral content except in localized areas such as Charleston, located between Hermiston and Umatilla, where iron and sulfer compounds impart an unpleasant taste and odor. Some concern has also been expressed over possible bacterial contamination of shallow wells in populated areas.

John Day Subbasin

Municipal

Approximately 59 percent of the subbasin's population of 15,600 are served by municipal water facilities. The town of John Day, which uses 0.5 mgd, has the largest municipal need.

Even though the municipal water requirement is only 2.4 mgd, shortages occur in many communities during the summer and fall months. Shortages are counteracted mainly by the regulation of lawn and garden sprinkling. These shortages are caused by inadequate storage and distribution facilities, by an insufficient water supply at the source, or by a combination of both.

With the exception of the town of Mitchell, all municipalities rely on ground water from springs or wells.

Industrial

The principal industrial water users are lumber mills, which are scattered throughout the areas. These mills have an average need of about 2.0 mgd. Most of the mills have their own sources of supply and do not depend on community water systems.

The largest industrial holder of water rights is the mining industry. However most of these rights are no longer in use or are used only intermittently. Only three mines are operated on a commercial basis at present.

Small quantities of water are also used by a few dairies and slaughterhouses.

The adequacy of water supplies for present industrial users has not been reported, but it is assumed that severe shortages do not occur.

Rural-Domestic

About 6,360 persons are served by individual water systems in the John Day Subbasin and use about 0.8 mgd. Ground water from wells and springs is the predominant source of supply for the rural-domestic population. The supply is generally adequate except during late summer and early fall, when shortages occur in many locations.

The quality of water obtained from springs and deep wells is usually good, and the water requires no special treatment. However, shallow wells are frequently contaminated bacterially by irrigation seepage and septic tank effluents.

Approximately 1.8 mgd are required for livestock watering. Normally, water for livestock is abundant during the spring grazing season in most areas. However, during the summer and fall, stored water is required to supplement the few perennial streams, springs, wells, and small ponds that have been developed to supply livestock water during periods of shortage.

Deschutes Subbasin

Municipal

Approximately 26,450 persons, or 58 percent of the subbasin's population, are served by municipal water systems. These

systems must provide for an average requirement of about 6.5 mgd. About one-half of this need is centered in the Bend Service Area.

Water supplies are derived from springs, wells, streams, and irrigation canals. The quantity of water available for municipal purposes is adequate at present.

The waters of the subbasin are generally of good quality. Ground-water quality is such that it can be used without any treatment except chlorination. Most surface-water supplies are also treated by chlorination only. However, municipal water obtained from irrigation canals usually needs complete treatment to remove or reduce bacteria, algae, turbidity, and color.

Industrial

Industrial water use is generally limited and scattered throughout the subbasin. The main water-using industries are lumber manufacturing, food processing, and sand-and-gravel operations.

The lumber and wood products industry has an average water requirement of about 9.6 mgd. About 5.6 mgd are required for lumber processing in the Bend Service Area.

At present, adequate water supplies exist for industries within the subbasin. Any new major water-using industries would be faced with the problem of securing adequate supplies, since most surface water has been appropriated (mainly for irrigation).

Rural-Domestic

About 19,350 persons, with an average water requirement of 2.4 mgd, are served by individual water systems. An estimated additional 2.5 mgd are needed for stock in the subbasin. Rural-domestic supplies are obtained from wells, streams, springs, and irrigation canals.

Shortages often occur in many parts of the subbasin because of the large number of streams that are dry in the summer months, in combination with many wells having a rate of recharge less than the rate of use. In some areas, surface water is not available and ground water lies only at great depths.

Ground water is generally of good quality and can be used for domestic purposes without treatment. Domestic and stock water from springs and streams is also of good quality and is commonly used without treatment. Many farms which use water from irrigation

canals should practice at least disinfection and probably some type of complete treatment.

Hood Subbasin

Municipal

About 27,420 persons, or 85 percent of the population of the Hood Subbasin, are served by municipal water facilities. The municipalities have an average water need of 6.7 mgd. The major population centers (The Dalles Service Area and the Hood River area) use 2.8 and 1.8 mgd respectively. Three group water systems (Crystal Springs, Lower Chenowith, and Chenowith Irrigation Cooperative) supply 1.5 mgd to 5,800 persons in fringe areas of The Dalles and Hood River.

The primary municipal water source for the Dalles is Mill Creek, and a supplemental supply is provided by wells. However, the community is in need of additional sources of supply since summer yields drop to critical levels. The Hood River water supply is piped from high mountain springs. Other municipalities generally rely on springs or wells for water sources.

Industrial

The largest industrial water users in the subbasin are the food-processing, lumber-manufacturing, and aluminum-processing industries. In general, the industrial water need of 16.2 mgd is supplied by surface sources.

The primary metals industry at The Dalles has an estimated industrial water use of 6.0 mgd. Several smaller industries within The Dalles Service Area are supplied by the municipal system and have a water requirement of approximately 1.5 mgd.

The fruit-processing industry is a moderate user of water. Fruit-processing plants located at Parkdale, Odell, Rockford, and Hood River have an annual average water requirement of about 0.3 mgd in washing fruit for fresh packing, in canning of fruits and juices, and in cold storage operations for condenser cooling. In addition, approximately 0.1 mgd are required for fruit spraying. Although no monthly data are available, it is known that the food-processing operation is highly seasonal, with peak demand during the period from June to September.

The lumber industry at Dee has a water requirement of about 7.0 mgd. Other small sawmill operations have only minor water requirements, totaling about 0.6 mgd.

Rural-Domestic

About 4,780 persons, or 15 percent of the subbasin's population, utilize individual or private water systems. This water is obtained for human and livestock consumption from springs, wells, streams, and irrigation ditches. There is a total demand of about 0.6 mgd.

Although there is an excess of potable water available for the subbasin as a whole, some residents of the high west side of the subbasin are presently short of domestic water.

The quality of water from both surface and ground sources is generally good. In agricultural areas, a few shallow wells and springs used by individuals for domestic purposes have shown bacterial contamination.

Klickitat Subbasin

Municipal

Approximately 8,960 persons, or 49 percent of the Klickitat Subbasin's population, are served by municipal water systems. There is an annual average water need of only 2.3 mgd. Goldendale is the largest community and has a municipal water requirement of about 0.65 mgd. The only other major population center is the White Salmon-Bingen area, which has a municipal water demand of about 0.58 mgd.

A few communities are in need of improved sources as a result of the lack of easily obtainable water in some parts of the subbasin.

Industrial

Little data are available as to the relative extent of industrial water use in the subbasin. The only major industrial water user is the lumber industry near Stevenson, Washington. Approximately 13 mgd are required to transport logs by flume from the uplands to a mill along the river. At present, other water use is limited to several small sawmills and plywood plants, which use about 2.0 mgd.

Rural-Domestic

Approximately 9,140 persons, or 51 percent of the subbasin's population, are served by individual water systems. This population has an annual average need of about 1.2 mgd. In addition, about 0.6 mgd are required for livestock watering.

FUTURE NEEDS AND MEANS TO SATISFY NEEDS

The principal factors that will determine future water needs in Subregion 7 are population growth and industrial expansion, particularly for food processing and forest products. As these increase, the demand for water will likewise increase.

The estimated 1965 population of 210,500 in the subregion is projected to increase 93 percent to 404,400 by 2020. Table 76 shows the projected population by subbasin and service area for the years 1980, 2000, and 2020. Nearly half of the population will be centered in the Walla Walla, Pendleton, Bend, and The Dalles Service Areas by 2020.

Production growth of the major water-using industries is projected to increase by more than 128 percent between now and 2020 in terms of value added. It is anticipated that food processing and forest products will continue to be major industries between now and the year 2020. These industries will, by 2020, account for 87 percent of the total value added by major water-using industries.

Municipal

Basis for Water Supply Projections

The population projected to be served by municipal water systems is shown in table 76. This projection indicates that by the year 2020 approximately 80 percent of the population will obtain water from central systems. The entire populations of the major service areas are expected to be served by central systems by that time.

Subregion 7 is in Climatic Designation 2, as defined in the "Future Needs" section of the Regional Summary for determination of projected municipal per capita water consumption. The average requirement is expected to be 275 gpcd in 1980, 295 gpcd in 2000, and 310 gpcd in 2020.

Table 76 - Projected Population, Subregion 7

	1980	2000	2020
	Thousands		
Walla Walla Subbasin	64.0	83.0	106.0
Walla Walla Service Area	39.5	56.6	73.9
Municipal	39.5	56.6	73.9
Rural	--	--	--
Other	24.5	26.4	32.1
Municipal	9.5	11.9	18.1
Rural	15.0	14.5	14.0
Subtotal	64.0	83.0	106.0
Municipal	49.0	68.5	92.0
Rural	15.0	14.5	14.0
Umatilla Subbasin	52.4	68.9	80.0
Pendleton Service Area	23.1	27.7	31.3
Municipal	23.1	27.7	31.3
Rural	--	--	--
Other	29.3	41.2	48.7
Municipal	15.3	26.2	31.7
Rural	14.0	15.0	17.0
Subtotal	52.4	68.9	80.0
Municipal	38.4	53.9	63.0
Rural	14.0	15.0	17.0
John Day Subbasin	16.0	16.0	16.0
Municipal	9.8	10.0	10.2
Rural	6.2	6.0	5.8
Deschutes Subbasin	60.0	77.0	93.4
Bend Service Area	18.1	24.5	31.3
Municipal	18.1	24.5	31.3
Rural	--	--	--
Other	41.9	52.5	62.1
Municipal	22.9	32.5	41.1
Rural	19.0	20.0	21.0
Subtotal	60.0	77.0	93.4
Municipal	41.0	57.0	72.4
Rural	19.0	20.0	21.0
Hood Subbasin	38.0	54.0	83.0
The Dalles Service Area	15.2	20.9	28.7
Municipal	15.2	20.9	28.7
Rural	--	--	--
Other	22.8	33.1	54.3
Municipal	17.8	27.1	47.3
Rural	5.0	6.0	7.0
Subtotal	38.0	54.0	83.0
Municipal	33.0	48.0	76.0
Rural	5.0	6.0	7.0
Klickitat Subbasin	21.0	23.0	26.0
Municipal	12.0	14.5	16.0
Rural	9.0	8.5	8.0
Total Subregion	251.4	321.9	404.4
Municipal	183.2	251.9	321.6
Rural	68.2	70.0	72.8

Projections of Water Supply Requirements

The anticipated municipal water requirements by subbasin and service area for the years 1970, 1980, 2000, and 2020 are presented in table 77. The present water use is forecast to increase to nearly 100 mgd by 2020. By 2020, municipal requirements will account for approximately 35 percent of the total subregional needs. Future needs are expected to be concentrated in the major service areas.

Table 77 - Projected Municipal Water Use, Subregion 7

	1970	1980	2000	2020
	MGD			
Walla Walla Subbasin				
Walla Walla Service Area	10.4	10.9	16.7	22.9
Other	3.4	2.7	3.6	5.7
	13.8	13.6	20.3	28.6
Umatilla Subbasin				
Pendleton Service Area	4.5	6.4	8.2	9.6
Other	3.6	4.3	7.9	10.0
	8.1	10.7	16.1	19.6
John Day Subbasin	2.5	2.7	3.0	3.2
Deschutes Subbasin				
Bend Service Area	3.9	5.0	7.2	9.7
Other	4.3	6.4	9.8	12.6
	8.2	11.4	17.0	22.3
Hood Subbasin				
The Dalles Service Area	3.3	4.2	6.2	8.9
Other	4.3	5.0	8.1	9.0
	7.6	9.2	14.3	17.9
Klickitat Subbasin	2.7	3.4	4.4	5.0
Total	42.9	51.0	75.1	96.6

Problems and Solutions

Adequate supplies exist for present municipal requirements in the subregion. Few problems in meeting future needs will occur in the service areas, and possible solutions are described below.

Walla Walla Subbasin All of the municipalities except Walla Walla can meet projected water supply requirements through further development of their existing supplies. The cities obtain their supplies from ground water, although Milton-Freewater supplements its supply from the South Fork of the Walla Walla.

Walla Walla derives its primary supply from Mill Creek. Unregulated flows in Mill Creek cannot meet future requirements. The proposed Blue Creek Reservoir on Mill Creek provides the most attractive source for future supplies. Alternative sources are the Walla Walla River through storage development and some combination of ground-water and surface-water development.

Umatilla Subbasin Further development of ground water will meet the needs of most municipalities in this subbasin. Some ground-water basins receive substantial recharge from irrigation, especially in the Hermiston area. Since ground water is also the source of supply, a potential exists for adverse effects from a water quality standpoint. More efficient irrigation practices would minimize this problem.

Consultants have recommended that Pendleton supplement its supply with surface water by 1975. Pendleton has an application for a surface-water right on the Umatilla River. This, in conjunction with the development of Ryan Reservoir, would meet future needs. An alternative would be the further development of ground-water supplies to the point of safe yield of the ground-water basin. A more expensive alternative would be to tap the Columbia River as a supply source.

John Day Subbasin Most municipal water supplies are derived from ground water. Inadequacies in supplies result mostly from inadequlately sized distribution works or inadequately developed sources. Sources of supply, both ground and surface water, are available for further expansion to meet needs. Economics will dictate the source selection, but it is probable that ground water will continue to be the primary supply source.

Deschutes Subbasin The Upper Deschutes area, above Benham Falls, contains a few small towns. Most supplies come from ground water, some from small streams. Supplies are adequate in quantity and quality to meet future needs, and source selection will be largely on an individual basis.

The Middle Deschutes area includes, Bend, Redmond, and Prineville. Most water supplies come from surface sources, although Prineville relies upon wells. Many towns and individuals divert their supplies from irrigation canals or ditches. There is an adequate supply of surface water to meet present and future needs as long as treatment is provided, although in some instances irrigation water rights may have to be purchased. In the Bend-Redmond area, raw wastes have been injected into the ground through wells for many years. Although there has been little measurable influence upon ground water, there is the potential of a serious, long-enduring health hazard. The cities have been directed to collect and treat their wastes in order to prevent further addition of raw wastes to the ground-water basin. Ground water is an alternative supply source, although this resource must be better defined before it will offer much potential.

The Lower Deschutes area has a few small towns, most of which utilize ground water for their supplies. These supplies are adequate to meet projected needs of this area.

Hood Subbasin There are few potential problems in meeting municipal water supply requirements. Both surface- and ground-water supplies are in abundance. Only in The Dalles can it be said that a problem exists; and, with the Columbia River at its doorstep as an alternative, there is no serious problem.

Klickitat Subbasin Most municipalities have supply sources adequate for both present and future requirements. Goldendale's ground-water source may not be adequate to serve more than half again the present demand. Projected growth is not large, however. If additional supplies are required, development of storage on a stream such as the Little Klickitat would be a likely source.

Industrial

Basis for Water Supply Projections

Projected industrial water use, as previously mentioned, is the product of a growth index and the present water use. The forecast growth indices for the major water-use categories are

Table 78 - Industrial Growth Indices, Subregion 7

	1980	2000	2020
	(Base Year 1963 = 1.00)		
Pulp and paper	1.34	2.12	2.31
Food products	1.66	2.30	3.18
Lumber and wood products	1.09	1.16	1.23
Primary metals	2.93	3.29	3.67

shown in table 78 for the years 1980, 2000, and 2020. The indices were derived from data presented in Appendix VI.

Projections of Water Supply Requirements

Projected water needs by major industrial categories are presented in table 79 for the years 1970, 1980, 2000, and 2020. By 2020, industrial needs will be nearly 140 mgd, or 51 percent of the total water needs in the subregion.

Table 79 - Projected Industrial Water Use, Subregion 7

	1970	1980	2000	2020
	-MGD-			
Lumber and wood products	32.4	41.9	44.6	47.5
Food products	13.5	17.5	24.1	33.3
Pulp and paper	15.2	19.6	25.0	36.1
Primary metals	13.6	17.6	19.7	22.0
Others	0.1	0.1	0.2	0.3
Total	74.8	96.7	113.6	139.2

The lumber and wood products and the pulp and paper industries will continue to be the major water users, requiring approximately 47 and 36 mgd, respectively, by 2020. The projected water use for pulp and paper includes a new plant along the Columbia River by 1980, which will use 10 mgd of water initially and which will expand to use 15 mgd by 2020. The water demand for the food products industry is expected to increase at the most rapid rate during the projection period, and will grow to be a relatively major water use.

In general, the increases in water use will occur at existing operations for most industries. However, some industries will develop new sites during expansion. There are several sites

along the Columbia River that can support a variety of new industries. A great deal of promotional activity is getting under way, which will intensify in the future, to encourage new industries to locate there.

Problems and Solutions

The food products industry is largely supplied through municipal systems. The remainder of the industries have developed their own supply sources, and this pattern is expected to persist into the future. Thus, the food products industry needs are included under municipal problems and solutions.

The pulp and paper and the primary metals industries draw their water supplies from surface sources, with the primary source being the Columbia River. There are more than adequate supplies from available sources for future needs of these industries, and no problems are predicted.

The lumber and wood products industries are scattered throughout all subbasins in the subregion. They are normally located along streams and divert surface waters for their use. Only a small growth in water use is projected for these industries, and most of the increased need can be drawn from excess winter flows of present sources. Limitations in supply will probably be accommodated by reductions in unit water usage.

Rural-Domestic

Basis for Water Supply Projections

The population expected to rely on individual water systems is shown in table 76. The projections show that nearly 20 percent of the population will be served by individual systems by 2020.

Based on assumptions presented in the "Future Needs" section of the Regional Summary, the expected requirement for the rural population will be 165 gpcd in 1980, 205 gpcd in 2000, and 250 gpcd in 2020.

The projected livestock population in the subregion is based on data presented in Appendix VI. It has been assumed for purposes of this study that the livestock water use per animal will remain constant during the projection period.

Projections of Water Supply Requirements

The anticipated rural-domestic water requirements are presented by subbasin for the years 1970, 1980, 2000, and 2020 in table 80, and are forecast to increase to about 37.4 mgd by 2020. Of this amount, approximately 18.0 mgd will be required for domestic purposes and 19.4 mgd for livestock watering.

Table 80 - Projected Rural-Domestic Water Use, Subregion 7

	1970	1980	2000	2020
	MGD			
Walla Walla Subbasin				
Domestic	2.1	2.5	3.0	3.5
Livestock	0.9	1.0	1.4	1.8
	3.0	3.5	4.4	5.3
Umatilla Subbasin				
Domestic	1.8	2.3	3.1	4.2
Livestock	2.3	2.9	3.9	5.1
	4.1	5.2	7.0	9.3
John Day Subbasin				
Domestic	0.8	1.0	1.2	1.4
Livestock	2.1	2.6	3.5	4.6
	2.9	3.6	4.7	6.0
Deschutes Subbasin				
Domestic	2.6	3.2	4.1	5.2
Livestock	3.0	3.7	4.9	6.4
	5.6	6.9	9.0	11.6
Hood Subbasin				
Domestic	0.7	0.8	1.2	1.7
Livestock	--	--	--	--
	0.7	0.8	1.2	1.7
Klickitat Subbasin				
Domestic	1.2	1.5	1.8	2.0
Livestock	0.8	0.9	1.2	1.5
	2.0	2.4	3.0	3.5
Total				
Domestic	9.2	11.3	14.4	18.0
Livestock	9.1	11.1	14.9	19.4
	18.3	22.4	29.3	37.4

Problems and Solutions

Rural-domestic requirements are scattered throughout the subregion. While the general trend is for more population concentrations in municipalities, there is still a steady growth of individual water supply needs here. In most instances, continual development of ground-water resources will meet these needs. In some areas such as the Middle Deschutes, surface waters may continue to meet a major part of the requirements, but even there more ground-water sources will be tapped in the future. Few significant problems that cannot be resolved individually are foreseen for this subregion.

LOCATION MAP

SUBREGION 8

S U B R E G I O N 8 - L O W E R C O L U M B I A

INTRODUCTION

Subregion 8 contains 5,103 square miles in the states of Washington and Oregon. The subregion consists of a portion of Columbia County, Oregon, and the drainage basins in Washington between Bonneville Dam and Grays Bay on the Columbia River estuary. Rolling hills predominate in the western section, and the local relief is not great, mostly less than 500 feet. The eastern portion is in the Cascade Range, with its rough topography rising to an elevation of over 14,000 feet.

Climatic conditions are modified somewhat from those of the Pacific Coast, but still there is high precipitation (40 to 100 inches) between November and April, with light rainfall during the summer months. Temperatures are greatly modified by the ocean's influence, which easily reaches inland over the low Coast Range. However, extreme temperatures of -20°F. to 107°F. have been recorded.

The discharge pattern of streams is characterized by minimum flows during the fall. Peak flows occur between November and June as a result of rainfall and snowmelt.

There are several types of manufacturing plants such as pulp and paper, lumber, textile, and aluminum. The production of pulp and paper is the most important economic activity. Agriculture and agricultural processing plants are of relatively minor importance. Recreation is becoming increasingly important because of the nearness of the major metropolitan areas of Portland and Olympia-Tacoma.

The population of the Lower Columbia Subregion is about 220,300 persons. About 58 percent of the population is concentrated along the Columbia River in the Vancouver-Camas and Longview-Kelso areas. Smaller communities are scattered through several valleys in the area.

PRESENT STATUS

Table 81 summarizes the municipal, major industrial, and rural-domestic water use for the service areas and the remainder of Subregion 8. At present, the requirement averages about 388.0 mgd, including a municipal demand of 24.7 mgd, an industrial

demand of 354.4 mgd, and a rural-domestic demand of 8.9 mgd. This need is generally concentrated in the major service areas. The Vancouver-Camas and Longview-Kelso Service Areas require about 43.6 and 47.7 percent, respectively, of the subregion's average water use.

Table 81 - Present Municipal, Major Industrial, and Rural-Domestic Water Supply Needs, Subregion 8

	Municipal	Industrial (MGD)	Rural-Domestic	Total	% Total Subregion
Vancouver-Camas Service Area	13.4	155.4	0.5	169.3	43.6
Longview-Kelso Service Area	7.2	177.3	0.6	185.1	47.7
Other	4.1	21.7	7.8	33.6	8.7
Total	24.7	354.4	8.9	388.0	100.0

About 66 percent of the population is served by municipal water systems. Approximately 56 percent of the systems depend primarily on ground-water sources, 37 percent on surface-water sources, and 7 percent on mixed supplies (figure 9).

The principal industrial water user is the pulp and paper industry, which requires about 283 mgd, or 80 percent of the total industrial use.

Table 82 summarizes annual distribution of monthly needs for the major water-use categories in each of the service areas. Since insufficient data are available concerning the monthly municipal pattern in the Longview-Kelso and Vancouver-Camas Service Areas, a statistical analysis of water supply distribution for similar areas in the Pacific Northwest was used to derive the figures. The maximum municipal monthly water need occurs from June to September. The month of July is the peak use month for the Vancouver-Camas area, and August is the peak month for the Longview-Kelso area. Available information for industries indicates that the only significant seasonal variation is for food processing. The maximum water use for the food-processing industry occurs between August and October.

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COMPREHENSIVE FRAMEWORK STUDY

WATER USE

LOWER COLUMBIA SUBREGION 8

1970

FIGURE 9

Table 82 - Monthly Variation in Water Needs, Subregion 8

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	Percent											
Vancouver-Camas Service Area												
Municipal	73	72	68	75	75	120	185	175	120	88	77	76
Pulp and paper	100	100	100	100	100	100	100	100	100	100	100	100
Primary metals	100	100	100	100	100	100	100	100	100	100	100	100
Food products*												
Chemical products	100	100	100	100	100	100	100	100	100	100	100	100
Longview-Kelso Service Area												
Municipal	77	89	77	91	86	111	123	138	113	97	78	89
Pulp and paper	100	100	100	100	100	100	100	100	100	100	100	100
Primary metals	100	100	100	100	100	100	100	100	100	100	100	100

*Insufficient data.

Water Quality

Surface Water

The surface water available for municipal and industrial purposes is generally of excellent quality. However, turbidity and suspended sediment problems often require that the water receive complete treatment before use.

All of the streams contain few dissolved minerals. With the exception of the main stem of the Columbia River, the dissolved solids concentration of the water of most streams averages less than 50 mg/l, and the average hardness is usually less than 20 mg/l. Calcium and bicarbonate are the predominant dissolved ions. The maximum dissolved solids content is usually less than 100 mg/l. The main stem of the Columbia River shows relatively little variation in chemical quality in the reach from Bonneville Dam to the estuary. The dissolved solids content since 1958 has ranged from approximately 70 to 160 mg/l. The quality of surface waters representative of municipal sources is listed in table 83.

A salinity study of the Columbia River made by the Corps of Engineers in 1959 indicates that salt-water intrusion reaches at least 16 miles upstream from the mouth, and recent studies at Oregon State University indicate that it might reach 23 miles. The maximum penetration of salt water was found during periods of low river flow.

Many streams contain considerable turbidity at certain times of the year. The Cowlitz River is nearly always milky in appearance because of silt associated with the glaciers of Mt. Rainier, Mt. St. Helens, and Mt. Adams. The Lewis River is less turbid because it drains only the southeast side of Mt. St. Helens and part of the west side of Mt. Adams.

Table 83 - Summary of Water Quality Data for Surface Water, Subregion 8

	River Mile	D.O. (mg/l)	T (°C)	Coliform MPN/100ml	pH	Color PT-CO Units	Hard. (mg/l)	Turb. (JTU)	TDS (mg/l)	Ortho PO_4 (mg/l)	NO_3-N (mg/l)
Washougal River	120.7-9.7										
Mean		--	--	--	6.9	4	8	1	25	0.027	0.08
Min.		--	--	--	6.3	0	6	0	20	0.01	0.02
Max.		--	--	--	7.2	10	11	5	34	0.06	0.27
Lewis River	87.0-5.2										
Mean		11.1	10.1	177	7.0	3	13	3	34	0.017	0.06
Min.		9.0	5.0	0	6.7	0	10	0	27	0.00	0.00
Max.		13.8	20.0	930	7.4	5	16	10	40	0.04	0.25
Lewis River	87.0-19.5										
Mean		10.8	9.1	3	6.9	4	11	--	32	0.013	0.026
Min.		8.3	5.0	0	6.5	0	10	--	29	0.00	0.00
Max.		12.4	13.0	36	7.4	5	12	--	38	0.03	0.05
Kalama River	73.1-1.3										
Mean		11.2	10.1	723	7.2	5	15	3	42	0.046	0.11
Min.		8.2	2.9	0	6.8	0	10	0	31	0.00	0.00
Max.		13.2	17.9	11,000	7.5	10	19	20	54	0.17	0.52
Cowlitz River	68.0-4.8										
Mean		10.9	10.7	178	7.2	6	19	9	45	0.029	0.07
Min.		8.0	2.8	0	6.8	0	12	0	30	0.00	0.00
Max.		14.4	21.7	930	7.6	20	27	65	61	0.06	0.23
Cowlitz River	68.0-29.8										
Mean		11.4	9.9	134	7.2	6	19	10	44	0.021	0.07
Min.		8.8	2.8	0	6.9	0	12	0	30	0.00	0.00
Max.		15.1	21.5	930	7.8	20	28	85	57	0.06	0.25
Cowlitz River	68.0-76.2										
Mean		11.4	8.8	67	7.3	5	20	8	43	0.028	0.03
Min.		9.2	1.1	0	7.0	0	12	0	30	0.00	0.00
Max.		13.6	18.0	360	7.7	20	26	50	58	0.08	0.09
Coweeman River	68.0-1.4-2.6										
Mean		10.6	11.1	1,819	7.0	9	20	6	49	0.044	0.31
Min.		5.6	3.5	0	6.4	5	12	0	37	0.01	0.09
Max.		13.8	23.2	24,000	7.5	20	36	20	70	0.27	0.68

Observed coliform densities indicate that such levels are generally low. However, the main stem Columbia from the Portland-Vancouver area to St. Helens exhibits bacterial concentrations well above the recommended limit of 1,000 organisms/100 ml for water-contact recreation. Bacterial counts near the Washington shore are generally higher than those along the Oregon shore. High bacterial levels are also found in the Columbia Slough and Coweeman River.

The Lower Columbia River is adversely affected by slime growth which flourishes periodically. The slime is a biological mass, primarily composed of bacterium Sphaerotilus, which serves as a matrix for the attachment of microscopic plants and animals, and debris. Commercial and sport fishing and other water-contact recreation are adversely affected by the slime growths.

Ground Water

The ground water is usually of good physical and chemical character. In general, the water is chiefly calcium-magnesium bicarbonate water; the dissolved solids concentration rarely

exceeds 300 mg/l; the water is soft to moderately hard; and troublesome trace constituents are absent. The mineral quality of ground-water supplies for selected communities is listed in table 84.

Table 84 - Mineral Water Quality of Ground-Water Supplies, Subregion 8

	SiO_2	Fe	Ca	Mg	Na	HCO_3 mg/l	SO_4	CL	NO_3	Total Solids	Hard. $CaCo_3$	F	pH
Vancouver, Wn. (Well #1) 1/13/69	7.0	0.74	31	15	4.0	134	21.4	10.5	2.3	150	140	0.11	7.2
Toledo, Wn. 6/20/68	24	0.06	12	13.4	3	95	1.9	4.5	3.4	131	80	0.2	7.3

Excessive iron concentrations have been reported in some domestic supplies, but this seems to be a local problem. In several marine sedimentary strata, highly saline water is found at depths beyond a few hundred feet. Bacterial contamination of ground water appears to be minimal.

The Public Utility District of Clark County has expressed concern about the possibility that continued withdrawal from the fresh water aquifers will cause the deeper brine water to migrate upward and contaminate the fresh water aquifer. As a precautionary measure, the district has applied for surface water rights on the Lewis River as a replacement for ground-water supplies along the Columbia.

Treatment

Table 85 summarizes water treatment practices of communities in the subregion. Mineral removal and specialized treatment are not listed. All surface-water sources receive at least disinfection before distribution, and most of the population are served by water receiving complete treatment. The majority of communities utilizing ground water provide disinfection before distribution.

Municipal

Approximately 66 percent of the population of the subregion, or 145,200 persons, are served by municipal water systems. The principal water use is centered in the Vancouver-Camas and Longview-Kelso Service Areas. Municipal requirements in these urban areas are 54 and 29 percent, respectively, of the total municipal water demand of the subregion (24.7 mgd).

Table 85 - Summary of Municipal Water Sources and Treatment Practices, Subregion 8

Source	Number of Municipal Facilities	Population Served Thousands	Percent of Total Population
Surface			
No treatment	-	--	--
Disinfection	8	9.6	6.6
Complete	3	44.7	30.8
	11	54.3	37.4
Ground			
No treatment	5	7.7	5.3
Disinfection	7	73.4	50.6
Complete	-	--	--
	12	81.1	55.9
Mixed			
No treatment	1	0.4	0.2
Disinfection	2	9.4	6.5
Complete	-	--	--
	3	9.8	6.7
Total	26	145.2	100.0

Ground water is quite important, supplying about 61 percent of the municipal water requirement. The most extensive use of ground water is in western Clark County, including the Vancouver-Camas Service Area, where alluvial deposits form vast water-bearing benches and terraces. Although limited alluvial deposits do occur elsewhere along the Lewis, Cowlitz, and Columbia Rivers, surface sources are the predominant water supplies for the remainder of the subregion. The most important surface source is the Cowlitz River, which serves the Longview-Kelso Service Area. Most other communities utilize tributaries of the Cowlitz River for water supplies.

There are abundant quantities of surface and ground water, and few critical shortages are reported by municipalities at the present time. However, the community of Rainier, Oregon, has water shortage problems nearly every summer.

Industrial

Industries are the largest users of water in Subregion 8, with a requirement of about 354 mgd. The pulp and paper industry is the major water user, having a daily requirement of 283 mgd. The next largest industrial water need is for cooling purposes by two chemical plants and two aluminum-processing plants. They require 31 and 25 mgd, respectively.

Major water-use centers are the Vancouver-Camas and Longview-Kelso Service Areas and the St. Helens area.

Industries in the Vancouver-Camas Service Area have a water requirement of about 155.4 mgd, including 116.8 mgd by the pulp and paper industry; 15.5 mgd by the aluminum-processing industry; 14.0 mgd by the chemical industry; 7.4 mgd by the food-processing industry; and 1.7 mgd by other industries. The largest individual water users are the pulp and paper mills. The primary metals and chemical industries are also important, with water needs of 14 and 15 mgd, respectively. The latter two use water principally for cooling purposes. Independently developed ground-water sources are generally used by these industries. However, a paper industry obtains about two-thirds of its water supply from Lacamas Lake.

The pulp and paper industry is the major industrial water user in the Longview-Kelso Service Area, requiring about 177 mgd. One mill obtains Columbia River water, which is treated for industrial as well as for domestic use by the company. Another mill uses water without treatment from backwaters created by the confluence of the Cowlitz River with the Columbia. The primary metals industry, the only other major industrial water user, withdraws about 10 mgd from the Columbia River.

A chemical plant near St. Helens uses about 17 mgd of Columbia River water for cooling purposes.

Other industrial water users are small and are scattered throughout the subregion.

Rural-Domestic

Approximately 75,100 persons, or 34 percent of the subregion's population, are served by individual water systems. This portion of the population has a water need of about 6.7 mgd. An additional 2.2 mgd are required for livestock watering.

In the western portion of Clark County, water is usually obtained from wells. Except for occasional high iron concentrations and high saline conditions in some marine sedimentary

strata, the water is of excellent quality. Adequate quantities are generally available for most domestic and livestock use. In other areas water supplies are usually obtained from springs or streams. The only quality problems usually result from turbidity during periods of high runoff.

FUTURE NEEDS AND MEANS TO SATISFY NEEDS

The principal factors influencing future water needs in Subregion 8 are population expansion and industrial growth. By 2020, the population is projected to reach 414,300, an increase of 88 percent over the 1965 population of 220,300. The projected population by subbasin and service area for the years 1980, 2000, and 2020 is shown in table 86. At the end of the projection period, over one-half of the subregion's population is expected to be located in the Vancouver-Camas Service Area; and the Longview-Kelso Service Area will account for over 25 percent.

Table 86 - Projected Population, Subregion 8

	1980	2000	2020
	Thousands		
Vancouver-Camas Service Area	119.3	163.6	223.7
Municipal	119.3	163.6	223.7
Rural	-	-	-
Longview-Kelso Service Area	60.4	79.8	109.2
Municipal	60.4	79.8	109.2
Rural	-	-	-
Other	75.2	81.0	81.4
Municipal	29.2	39.2	45.6
Rural	46.0	41.8	35.8
Total Subregion	254.9	324.4	414.3
Municipal	208.9	282.6	378.5
Rural	46.0	41.8	35.8

Industrial development in the future will continue to be based on the subregion's abundant forest resources. Production growth of the major water-using industries is projected to increase by more than 360 percent between now and 2020 in terms of value added. Pulp and paper and primary metals will be the major industries by the end of the projection period. These industries will account for 73 percent of the total value added by major water-using industries.

Municipal

Basis for Water Supply Projections

The projected population to be served by municipal water systems, as shown in table 86, indicates that by the year 2020, approximately 90 percent of the population will obtain water from central distribution systems. The entire population of the major service areas is expected to be served by central distribution systems by that time.

The Lower Columbia Subregion is in Climatic Designation 1, as defined in the "Future Needs" section of the Regional Summary, for determination of projected municipal per capita water consumption. The average requirement is expected to be 205 gpcd in 1980, 225 gpcd in 2000, and 240 gpcd in 2020.

Projections of Water Supply Requirements

The projected municipal water requirements by service area for the years 1970, 1980, 2000, and 2020 are presented in table 87. The present use is forecast to increase to 100 mgd by 2020. Future needs are expected to be concentrated in the major service areas. The Vancouver-Camas Service Area is expected to require over 60 percent of the municipal demand by the end of the projection period.

Problems and Solutions

Most supplies are considered to be adequate for present and projected requirements; however, Rainier, Oregon, experiences water shortages during the summer.

It is expected that in the future all supplies will be provided at least disinfection and surface supplies will receive complete treatment.

Table 87 - Projected Municipal Water Use, Subregion 8

	1970	1980	2000	2020
	MGD			
Vancouver-Camas Service Area	18.9	27.4	41.7	60.4
Longview-Kelso Service Area	9.9	14.0	20.3	29.5
Other	4.5	5.7	8.4	10.5
Total	33.3	47.1	70.4	100.4

Basis for Water Supply Projections

Projected industrial water-use requirements are the product of a growth index and present water use. The growth indices were derived from data presented in Appendix VI. Water use per unit of product was assumed to remain unchanged for purposes of estimating future needs.

Projections of Water Supply Requirements

Projected water requirements by major industrial categories are shown in table 88 for the years 1970, 1980, 2000, and 2020. It is assumed that industrial growth will occur in the vicinity of existing operations. The pulp and paper industry in the Longview-Kelso Service Area will continue to be the largest water user, with slightly less water being used by that industry in the Vancouver-Camas Service Area during the projection period. The pulp and paper industry will require approximately 80 percent of the subregion's industrial water.

Table 88 - Projected Industrial Water Use, Subregion 8

	1970	1980	2000	2020
	MGD			
Pulp and paper	317.2	402.0	586.0	654.0
Primary metals	39.1	49.5	56.4	63.0
Chemical products	37.8	47.9	72.3	101.1
Food products	10.6	13.4	18.7	25.8
Lumber and wood products	3.0	3.8	3.9	3.6
Other	1.4	1.8	1.9	2.0
Total	409.1	518.4	739.2	849.5

Problems and Solutions

Sufficient quantities of water are available to meet projected industrial water needs; therefore, no major problems are anticipated. There may be isolated problems regarding quality, and these can best be solved on an individual basis.

Rural-Domestic

Basis for Water Supply Projections

The rural population expected to rely on individual water systems is shown in table 86. The projections show that less than 10 percent of the subregion's population will depend on individual systems by 2020.

Based on assumptions presented in the "Future Needs" section of the Regional Summary, the expected per capita water consumption by the rural population will be 60 percent of that used in nearby communities in 1980, 70 percent of the municipal use in 2000, and 80 percent in 2020. The per capita use is projected to be 125 gallons per day in 1980, 160 in 2000, and 195 in 2020.

The livestock water component of the rural-domestic demand was derived by applying present per animal water-use factors to the projected subregional large animal population presented in Appendix VI. Water use per animal is expected to remain constant during the projection period.

Projections of Water Supply Requirements

The anticipated rural-domestic water requirements are presented for the years 1970, 1980, 2000, and 2020 in table 89. The rural-domestic need is expected to increase, by 2020, to about 12.2 mgd, of which 7.0 mgd will be required for domestic purposes and 5.2 mgd for livestock watering.

Table 89 - Projected Rural-Domestic Water Use, Subregion 8

	1970	1980	2000	2020
	MGD			
Domestic	5.7	5.8	6.7	7.0
Livestock	3.0	3.0	4.0	5.2
Total	8.7	8.8	10.7	12.2

Problems and Solutions

No widespread problems are foreseen in satisfying the future rural-domestic water supply needs. Most of the water in the western portion of Clark County is obtained from wells, and in other areas spring and stream supplies are used. No problems of quantity are anticipated; however, isolated cases of high iron concentrations and high saline conditions can be expected from the wells and turbidity problems from the surface supplies. These problems can best be treated on an individual basis.

AD-A036 556 PACIFIC NORTHWEST RIVER BASINS COMMISSION VANCOUVER WASH F/G 8/6
COLUMBIA-NORTH PACIFIC REGION COMPREHENSIVE FRAMEWORK STUDY OF --ETC(U)
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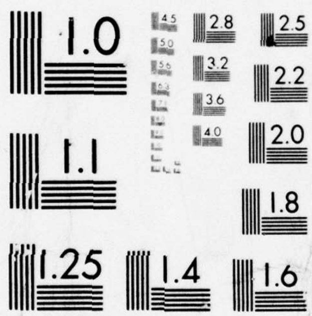


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

LOCATION MAP

SUBREGION 9

WILLAMETTE

INTRODUCTION

Subregion 9 covers an area of 12,046 square miles in northwestern Oregon. It is separated from the Deschutes Basin on the east by the Cascade Range; from the Umpqua Basin on the south by the Calapooya Mountains; and from several coastal stream basins on the west by the Coast Range. Elevations range from less than 10 feet along the Columbia River to 450 feet on the valley floor at Eugene, and over 10,000 feet in the Cascade Range.

The subregion has a climate with dry, moderately warm summers and wet, mild winters. Average annual precipitation is 63 inches, of which about 70 percent occurs during November through March and only about 5 percent from June through August. Normal annual amounts of precipitation vary from over 200 inches in small areas near the crest of the Coast Range to less than 40 inches near the center of the valley. Normal temperatures at the lower elevations vary from about 40°F. in January to 67°F. in July. Temperatures rarely drop below 0°F. and seldom exceed 100°F.

Maximum streamflows occur between the months of November and April--a direct result of runoff from precipitation and snowmelt; minimum flows occur between July and October. The streams draining the high Cascade area have sustained summer flows resulting from water stored in porous volcanic formations and snowmelt, whereas the flow in the Coast Range and lowland streams drops off rapidly during the dry season.

The economy in the subregion is diverse. The major industrial activities are pulp and paper production, food processing, primary metals processing, manufacturing, agriculture, textile production, and chemical production. The major employment areas are (in order of 1960 employment): (1) retail trade; (2) medical and other professional services; (3) lumber, wood products, and furniture; (4) contract construction; (5) wholesale trade; (6) public administration; and (7) agriculture.

Population of the subregion is about 1,338,900 persons. The rate of population growth has equalled or exceeded the national average during each decade since 1900. About 79 percent of the people live in the four major service areas. There are 45 communities with populations in excess of 1,000.

For purposes of this appendix, the subregion (figure 10) is divided into the Upper Willamette, Middle Willamette, and Lower Willamette Subbasins. Figure 10 also shows present water use. The service areas are the Eugene-Springfield, Albany-Corvallis, Salem, and Portland areas. All data on present and projected population and water use were derived from information presented in the Type 2 Study. (18) In the Type 2 Study, industries which obtain their water from a municipal system are included in the "Municipal" category. Since the reporting format for this Appendix requires that all industrial water use be included in the "Industrial" category, appropriate adjustments were made in the municipal and industrial water use data presented in Reference 18 to include the municipally supplied industries in the "Industrial" category.

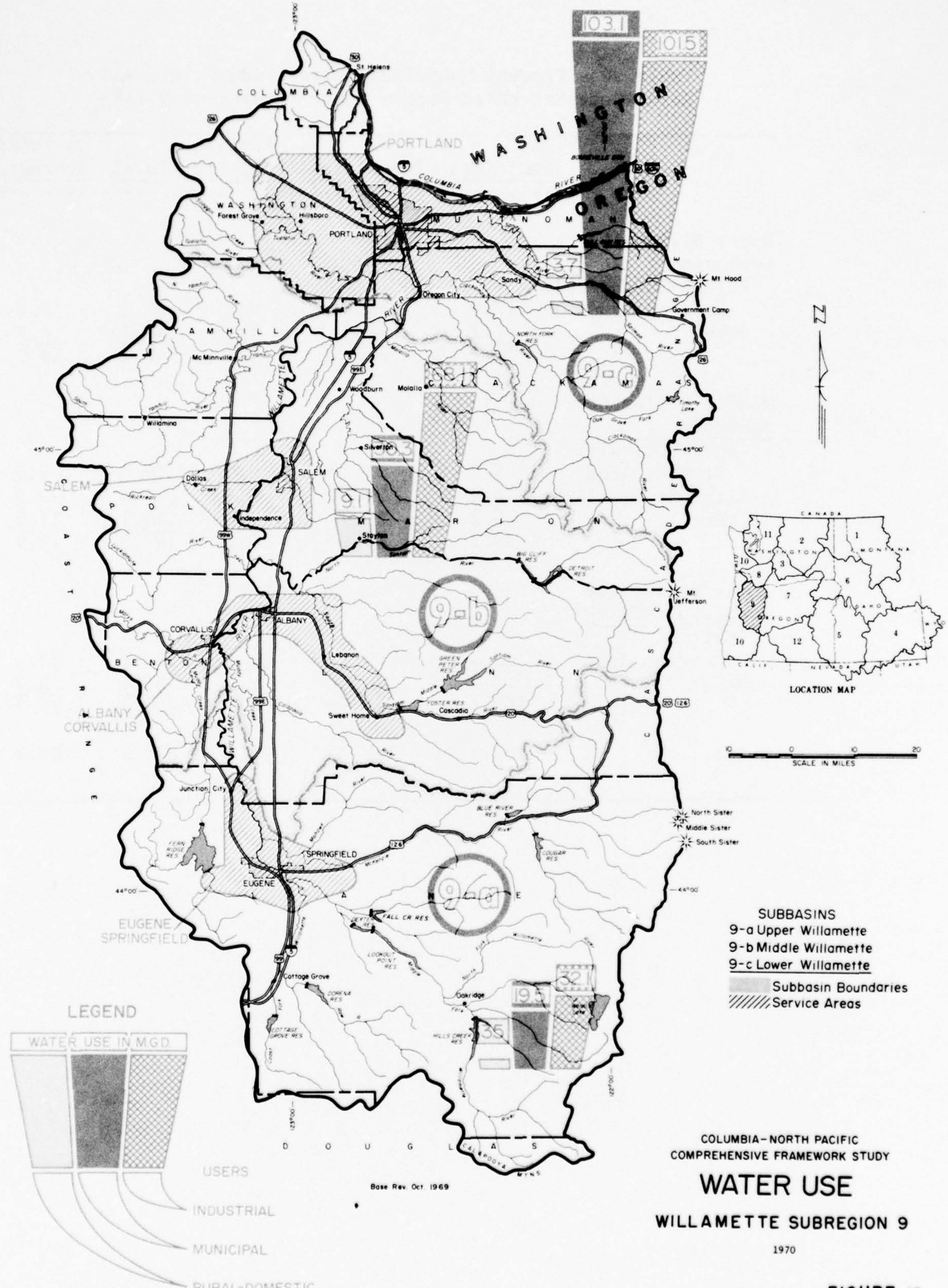
PRESENT STATUS

Table 90 summarizes present municipal, major industrial, and rural-domestic water use in the subregion. At present, the water requirement averages about 370.9 mgd, including a municipal demand of 152.9 mgd, an industrial demand of 201.7 mgd, and a rural-domestic demand of 16.3 mgd. This need is concentrated in the major service areas. The Portland, Eugene-Springfield, Salem, and Albany-Corvallis Service Areas require about 46.5, 10.5, 9.9, and 8.0 percent, respectively, of the average annual water requirement.

About 84 percent of the population is served by municipal water systems. Approximately 83.1 percent of the municipal population depends on surface water sources, 9.2 percent on mixed supplies, and only 7.7 percent on ground-water sources.

The principal industrial water use is for pulp and paper production. It requires about 128 mgd, or 64 percent of the total industrial demand. Other significant industrial water users are lumber and wood products and food processing. These industries require 32.5 and 16.0 mgd, respectively.

Major water-use categories are summarized in table 91 for each of the service areas. Municipal need is highest from June through August during the annual summer drought that normally occurs in the Willamette Subregion. The forest products industry shows little seasonal variation in water demand. The food-processing industry experiences peak monthly requirements in September from 1.5 to 6 times the average monthly demand.



COLUMBIA–NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

WATER USE

WILLAMETTE SUBREGION 9

1970

FIGURE 10

Table 90 - Present Municipal, Major Industrial, and Rural-Domestic Water Supply Needs, Subregion 9 (18)

	Municipal	Industrial	Rural-Domestic	Total	% Total Subregion
	MGD				
Upper Willamette Subbasin					
Eugene-Springfield Service Area	17.4	20.6	0.7	38.7	10.5
Other	2.1	11.5	2.8	16.4	4.4
	19.5	32.1	3.5	55.1	14.9
Middle Willamette Subbasin					
Albany-Corvallis Service Area	8.2	21.1	0.5	29.8	8.0
Salem Service Area	14.9	21.1	0.8	36.8	9.9
Other	7.2	25.9	7.8	40.9	11.0
	30.3	68.1	9.1	107.5	28.9
Lower Willamette Subbasin					
Portland Service Area	99.4	72.1	1.0	172.5	46.5
Other	3.7	29.4	2.7	35.8	9.7
	103.1	101.5	3.7	208.3	56.2
Total	152.9	201.7	16.3	370.9	100.0

Table 91 - Monthly Variation in Water Needs, Subregion 9

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	Percent											
Eugene-Springfield Service Area												
Municipal	71	63	67	70	71	151	221	172	104	79	64	65
Pulp & paper	78	89	92	102	108	113	108	111	108	107	105	78
Lumber & wood products	107	113	100	121	103	102	94	106	106	89	84	76
Food products	8	7	7	4	8	5	62	183	361	276	160	120
Albany-Corvallis Service Area												
Municipal	75	74	77	74	76	137	191	166	99	79	74	78
Pulp & paper	100	100	100	100	100	100	100	100	100	100	100	100
Lumber & wood products	91	105	97	100	106	105	93	98	98	91	111	106
Food products	100	18	3	5	7	10	59	242	602	86	46	22
Primary metals	59	29	13	39	30	40	45	81	180	267	200	216
Salem Service Area												
Municipal	62	54	59	67	70	132	203	183	130	106	66	68
Pulp & paper	100	100	100	100	100	100	100	100	100	100	100	100
Lumber & wood products	53	72	88	94	80	110	104	191	79	95	109	125
Food products	200	100	80	49	60	124	53	124	151	135	75	49
Portland Service Area												
Municipal	74	119*	76	85	80	103	168	127	112	100	78	78
Pulp & paper	100	100	100	100	100	100	100	100	100	100	100	100
Lumber & wood products	100	100	100	100	100	100	100	100	100	100	100	100
Food products	29	3	0	0	0	17	102	48	248	302	302	149
Primary metals	100	100	100	100	100	100	100	100	100	100	100	100

*Appears excessively high but is substantiated by city records.

Water Quality

Surface Water

The quality of the subregion's surface waters used for municipal and industrial water supply may be generally described as good. The primary constituents that must be removed or treated before use are sediment, taste- and odor-producing biological growths, and bacteria.

The surface waters are a calcium-magnesium bicarbonate type, with these ions making up about 70 percent of the total dissolved ions. The dissolved solids content of waters of most streams ranges from less than 40 mg/l to a maximum of about 85 mg/l. Hardness is generally less than 30 mg/l, and in many areas less than 20 mg/l. Some small streams on the valley plain that receive their base flows from terrace deposits, particularly the Willamette Silt, may contain dissolved solids in excess of 100 mg/l during low-flow periods. The mineral quality of water shown in table 92 for the cities of Portland, Salem, and Eugene is typical of the major surface-water supplies, which are obtained from tributary rivers arising in the Cascades.

Sediment transport and suspended organic matter such as fiber from pulp mills create local periodic water quality problems. In periods of low discharge, the river carries almost no suspended matter; however, sediment concentrations increase in most tributaries and in the main stem during periods of high runoff. The same

Table 92 - Mineral Water Quality of Surface-Water Supplies, Subregion 9

Content		Portland	Salem	Eugene	PHS Recom. Limit
		-mg/l, except pH-			
Total solids	(residue or evaporation)	35	35	59	
Volatile solids	(loss on ignition)	3	NR*	28	
Fixed solids	(residue after ignition)	32	NR	31	
Alkalinity	(as $CaCO_3$)				
Carbonate		0	0	0	
Bicarbonate		11.0	15.0	28.0	
Hardness	(as $CaCO_3$)	11.7	15.5	NR	
Silica	(SiO_2)	8.0	14.0	21.6	
Calcium	(Ca)	2.7	3.8	6.7	
Magnesium	(Mg)	1.2	1.5	1.1	
Iron	(Fe)	0.13	0.07	0.26	0.30
Aluminum	(Al)	0.1	0.3	0.028	
Manganese	(Mn)	0.0	0.0	<0.015	0.05
Sodium	(Na)	1.1	2.0	4.12	
Potassium	(K)	0.5	0.1	1.04	
Chloride	(Cl)	2.4	3.0	1.59	250
Sulfate	(SO_4)	1.3	1.2	1.2	250
Nitrate	(NO_3)	0.13	0.0	0.06	45
Fluoride	(F)	0.04	0.0	0.08	1
Phosphate	(PO_4)	0.0	NR	0.125	
pH		7.3	6.8	7.75	

*NR--not reported.

condition occurs periodically below gravel-removal sites and construction areas. The settleable solids from pulp and paper operations add to bottom sludge deposits and exert a considerable oxygen demand in the lower Willamette River.

Biological organisms, including Sphaerotilus, impart obnoxious taste and odor to many waters. The Willamette, lower McKenzie, South Santiam, and Tualatin Rivers are the most notable examples of this condition. Several reservoirs also suffer from prolific algal production.

Bacterial contamination resulting from man's activities is present in nearly every stream. Only the most undeveloped and well-managed watersheds are relatively free from the influence of man. The bacteriological quality of the main stem Willamette is generally unsuitable for a municipal or industrial water supply without sedimentation, filtration, and disinfection. The upper reaches of most tributaries are usually of excellent bacteriological quality. However, the lower reaches would need complete treatment before distribution. Only the Middle Fork Willamette, the McKenzie, and the Clackamas meet raw water supply objectives throughout their lengths.

Ground Water

The mineral quality of ground-water supplies for selected communities is listed in table 93. The quality of these waters frequently reduces their desirability as a municipal source. Excessive hardness, salinity, and iron are among the properties

Table 93 - Mineral Water Quality of Ground-Water Supplies, Subregion 9 (7)

	SiO_2	Fe	Ca	Mg	Na	Al	SO_4	Cl	Mn	Total Solids	Hard. $CaCO_3$	F	pH
							mg/l						
Clackamas Heights W.D.													
New well 1-13-54	45	0.1	19.4	3.6	28	0	1.2	13	0.02	250	93	0.3	7.5
Dayton													
Well #1 4-20-54	3.2	5	4.5	4.5	7.4	0	3.8	3.5	0.1	101	23	0.2	7.4
Well #2 4-20-54	3.8	NR*	33	9	8.6	0	6.0	6.8	0.5	392	116	0.1	7.8
Fairview													
Well at city	28	0.01	16.2	16.7**	8.5	0.05	2.6	5.9	<0.01	165	109.0	0.2	8.35
Independence													
System--4 wells 8-19-60	31.2	0.20	28.8	18.2**	NR	0.05	7.4	10.8	0.05	222	146.7	0.3	6.9
Jefferson													
Well #1 4-10-61	33.5	0.08	17.3	25.0**	8.0	<0.05	33.2	6.7	<0.05	223	146.0	0.1	7.3
Well #2 4-10-61	34.0	0.58	18.6	27.7**	7.0	<0.05	41.0	6.3	<0.05	223	160.0	0.1	7.4
Well #3 4-10-61	33.0	1.78	16.2	25.0**	9.0	<0.05	39.6	7.7	<0.05	204	143.0	0.1	7.5
Newberg													
System-wells & springs 7-14-60	49.0	3.0	15.1	13.4	7.8	0.08	4.6	4.7	0.14	163	92.8	0.05	7.8
Scio													
Well #1 4-10-61	27.0	1.8	13.7	8.5**	6.0	<6.02	16.8	6.3	0.53	101	69.1	<0.1	6.85
Well #2 4-10-61	25.0	0.11	11.9	9.2**	8.0	<0.05	5.0	27.2	<0.05	155	67.4	0.1	7.4
Springfield-PP&L System													
System-wells 6-15-61	20.5	6.08	6.0	7.1**	3.8	0.05	1.3	3.5	<0.05	52	44.2	<0.05	6.6
Woodburn													
Well #1 2-9-54	41	4	15.4	12.4	5.3	0	1.4	0.2	0	155	91	0.3	7.4
Well #2 2-9-54	41	1.5	15.6	13.3	5.2	0	0	0.2	0.05	165	87	0.3	7.5
Well #4 2-9-54	41	0.6	22.0	11.3	5.0	0	NR	1.2	0.05	250	91	0.3	7.8
Wood Village (Portland)													
Well 4-4-60	NR	0.05	16.2	16.2**	NR	NR	1.0	0.9	0.23	175	107.6	<0.01	7.4
Scappoose, Oregon 8-2-54	40	0.36	.19	1.2	11		1.7	2.3		174	84	0.3	7.9

* NR--Not reported.
** Calculated.

which have prevented extensive use of ground water in some areas. The constituent most commonly exceeding the recommended limit is iron. The recommended manganese concentration is also exceeded in some cases.

The quality of ground water used for rural-domestic supplies is quite important since such supplies rarely receive treatment before use. The natural quality of ground water is variable. The quality along the flood plain of the valley usually reflects the quality of the rivers. Hardness is the most widespread objectionable feature in ground water, but other naturally present contaminants such as arsenic also occur in limited areas. Brackish or saline water is encountered at depth throughout the Willamette River Basin.

Bacterial contamination of the aquifers is not uncommon in urbanized areas, and some supplies have been rendered unsuitable for human use unless treatment is provided.

Treatment

A summary of municipal water treatment practices in Subregion 9 is presented in table 94. Mineral removal and specialized treatment are not listed. Over one-half of the communities relying on underground sources disinfect water supplies. Mineral removal is practiced at Newberg, and softeners are used on an individual basis at Lake Oswego and other places using hard water from ground sources. Communities utilizing mixed or surface supplies generally provide at least disinfection before distribution. Municipalities withdrawing water from major tributaries usually operate complete treatment facilities (chemical coagulation, sedimentation, rapid sand filters, and chlorination). It is the policy of the Oregon State Board of Health to require complete treatment of all water from surface sources prior to use in public systems. Only exceptionally well protected watersheds are exempt from this policy.

Upper Willamette Subbasin

Municipal

Approximately 149,300 persons, or 75 percent of the subbasin's population, are served by municipal water systems. The municipal population has an average annual water requirement of 19.5 mgd. About 90 percent of this demand is centered in the Eugene-Springfield Service Area.

The Eugene-Springfield Service Area, which includes the communities of Eugene, Springfield, Coburg, Junction City, and the Elmira-Veneta area, has an average municipal water requirement of about 17.4 mgd. The McKenzie River is the primary source of water for the service area, supplying the City of Eugene. All other communities in the service area utilize underground supply sources. Several industries within the service area, including the lumber and wood and food processing industries, rely upon municipal facilities for their supplies. In the Type 2 Study (18) present and projected water use for these industries are included in the municipal category, but projections of future use are based on growth indices for the respective industries. The reporting format for this Appendix, however, requires that these municipally supplied industries be included in the industrial category.

Most communities outside of the Eugene-Springfield Service Area with significant water needs utilize surface-water supplies. Only Creswell and Harrisburg obtain supplies from ground-water sources. However, higher than desirable levels of arsenic from natural sources have been noted in some wells in the vicinity of Creswell, and excessive hardness has been reported in the water supply for Harrisburg.

Table 94 - Summary of Municipal Water Sources and Treatment Practices, Subregion 9

Source	Number of Municipal Facilities	Population Served Thousands	Percent of Total Population
Surface			
No treatment	-	-	-
Disinfection	21	689.1	69.7
Complete	9	132.1	13.4
	30	821.2	83.1
Ground			
No treatment	18	27.1	2.7
Disinfection	22	50.0	5.0
Complete	-	-	-
	40	77.1	7.7
Mixed			
No treatment	2	2.0	0.2
Disinfection	6	88.6	9.0
Complete	-	-	-
	8	90.6	9.2
Total	78	988.9	100.0

Industrial

The industrial water use in the Upper Willamette Subbasin is 32.1 mgd. The principal water-using industries are the lumber and wood products and the pulp and paper industries. These industries have average water needs of 20.8 and 7.8 mgd, respectively. Minor quantities of water are required for the food-processing industry.

About 20.6 mgd are required by industries in the Eugene-Springfield Service Area. The largest industrial water user is the wood and paper industry in Springfield. This industry requires 7.8 mgd for pulp and paper manufacture and 4.9 mgd for lumber and wood products. The industry holds a water right of 80 cfs (51 mgd) from the McKenzie River. During periods of high runoff, which result in high turbidity, solids cause excessive wear on hydraulic debarkers. As a result, the industry provides treatment for about 6 mgd. The remaining industrial water demand in the service area is primarily by lumber and wood products

plants, which require approximately 4.5 mgd. Water is generally withdrawn from independently developed surface sources, although several small plants utilize underground or municipally supplied sources. The food-processing industry also has a minor requirement, which is usually satisfied by drawing from municipal systems.

The largest industrial water user outside of the Eugene-Springfield Service Area is the lumber and wood industry at Cottage Grove. The average intake is about 10 mgd. Water is used primarily for steam production, hydraulic debarking, and log pond filling. Other industrial water users include small forest products plants and gravel-washing operations.

Rural-Domestic

Approximately 48,700 persons, or 25 percent of the Upper Willamette Subbasin's population, are served by individual water systems. This portion of the population has an average annual water requirement of about 3.5 mgd. In general, the rural community depends upon adequate underground sources for its water supply. However, some areas are characterized by low yields and/or hard water. It has been reported that some wells south and southwest of Eugene produce water with excessive arsenic concentrations.

Middle Willamette Subbasin

Municipal

Approximately 237,000 persons, or 72 percent of the Middle Willamette Subbasin's population, are served by municipal water facilities. Municipalities have an average annual water requirement of 30.3 mgd. Most of this demand is centered in the Albany-Corvallis and Salem Service Areas.

The Albany-Corvallis Service Area, which includes Albany, Corvallis, Philomath, Lebanon, and Sweet Home, has an average annual municipal requirement of about 8.2 mgd. All communities in the service area rely upon surface-water sources for their supplies. Albany, Lebanon, and Sweet Home withdraw water from the South Santiam River. The City of Corvallis utilizes the Willamette River and a small tributary. Complete conventional treatment (chemical coagulation, sedimentation, filtration, and chlorination) is practiced by the communities in the service area. A number of industries in the area are served by the municipal water systems. No problems in supplying demands from natural flows have been reported.

The Salem Service Area, which includes Salem, Dallas, Independence, Monmouth, and Turner, has an average municipal water requirement of about 14.9 mgd. The City of Salem accounts for nearly 90 percent of the municipal water use in the service area. Salem takes water from the North Santiam River through an infiltration gallery. The other communities in the area withdraw from small tributary creeks or ground-water sources. The City of Dallas, which withdraws from six small creeks, has experienced water supply shortages in recent years. The ground-water source for the town of Independence produces water that is slightly hard.

Most communities in the Santiam drainage area use water from the North Santiam River or small tributaries. Only a few small towns completely depend upon ground-water sources, although several communities utilize ground water for a supplemental supply.

The communities on the eastern slope of the Coast Range have primarily sought either springs or upper reaches of mountain streams for their supplies. Dallas and McMinnville have constructed storage facilities to satisfy peak summer demands. Several ground-water supplies in the Coast Range area exhibit excessive iron and manganese concentrations.

In the Pudding and Molalla drainage areas, most communities rely upon underground sources for supplies. A number of these communities have reported problems with excessive iron and manganese concentrations, and some water is slightly hard. Molalla and Silverton are the only major communities in the drainage area withdrawing from streams.

Industrial

The industrial water use in the Middle Willamette Subbasin is 68.1 mgd. The principal industrial water users are the pulp and paper, lumber and wood products, and food-processing industries. These industries have average needs of about 44.2, 10.7, and 9.1 mgd, respectively. Minor industrial water uses include primary metals and manufacturing.

About three-fifths of the industrial water use is concentrated in the Albany-Corvallis and Salem Service Areas. The service areas each have industrial water demands of about 21.1 mgd.

In the Albany-Corvallis Service Area, the major industrial withdrawal is by a pulp and paper mill at Lebanon. This sulfite process mill takes about 7.9 mgd from the South Santiam River above Lebanon. An unbleached kraft liner board mill at Albany requires about 7.4 mgd. Water is withdrawn from the Willamette River, and no treatment is provided except for boiler feed water

to control scale and corrosion. The major water-using lumber and wood products mill in the area is located at Lebanon and uses about 1.9 mgd from the Santiam River and wells. An industry near Albany takes about 1.6 mgd from the Willamette for processing rare metals. Diatomaceous earth filters are used to treat the process waters. Other industrial water users are either self-supplied or supplied by municipal water systems.

In the Salem Service Area the major industrial water use is by the pulp and paper industry, which diverts water from the North Santiam River through a canal to a mill at Salem. This plant, a sulfite pulp and fine paper mill, completely treats and uses approximately 16.1 mgd of water. Food processing has an annual average requirement of about 2.1 mgd, with 7 mgd peaks during the canning season. A portion of the water diverted by the City of Salem is used for this purpose, although several firms have developed independent ground-water sources.

The major withdrawal of water outside of the two service areas is by the pulp and paper industry at Newberg. This plant produces unbleached pulp and requires about 12.9 mgd from the Willamette River for plant operations. The quality of the water is controlled by filtration, chlorination, and deionization. It is also necessary for this plant to supplement the river supply with city water during the summer (0.1 mgd during August and September) when the river water temperature is higher than desirable for acid mixing. Other major industrial water use is by the food-processing and lumber and wood products industries, which require 6.6 and [illegible] mgd, respectively. The water demand for food processing is generally satisfied by using municipal water systems, although one plant at Woodburn takes about 1.3 mgd from wells. The lumber and wood products plants are concentrated along the Santiam River. Approximately 4.1 mgd are withdrawn from the river by these mills. One plant at Willamina uses about 1.5 mgd from the Yamhill River.

Rural-Domestic

Approximately 92,900 persons, or 28 percent of the Middle Willamette Subbasin's population, are served by individual water systems. This portion of the population requires about 9.1 mgd. In general, the rural population in headwater areas of major tributaries depends upon springs or small creeks for its water supplies. Water shortage problems occur in these areas during the summer period of low streamflow. In the valleys and along the Willamette River, ground-water sources are most often used for supplies.

Lower Willamette Subbasin

Municipal

The Lower Willamette Subbasin is the most densely populated in Subregion 9 and also has the greatest demand for water. Approximately 750,200 persons, or 92 percent of the subbasin's population are served by municipal systems. Municipalities require 103.1 mgd. Most of this need is centered in the Portland Service Area, which includes Boring, Cornelius, Forest Grove, Hillsboro, Sherwood, Sandy, and the Portland Urban Area. The Portland Urban Area is defined as: Multnomah County, including Portland, Fairview, Gresham, and Wood Village; Clackamas County, including West Linn, Oregon City, and Milwaukie; a portion of the Tualatin Basin, including Beaverton, Tigard, and Tualatin; and portions of the Sandy and Clackamas Basins.

The Portland Service Area has an average annual municipal water requirement of about 99 mgd. The largest single source has been developed by the City of Portland in the Bull Run watershed. The transmission facility is composed of three conduits about 25 miles long with a total capacity of 225 mgd. The present upstream storage totals 23,200 mg within the watershed. The natural quality of the water, and watershed management practices have made it possible to provide water satisfactory for distribution after treatment by simple chlorination only. Other supplies in the service area include ground water, small creeks, and the Clackamas River. Municipalities of the Tualatin River drainage rely partially upon water from other basins for their supplies at the present time. The communities of the Tualatin area have experienced water shortages and have lost industries for lack of water. Actions taken to gain an adequate supply for present needs include endorsement by the affected municipalities of the Bureau of Reclamation's Tualatin Project, which recommended storage for Forest Grove, Hillsboro, Beaverton, Tigard, and Lake Oswego.

The municipal water requirement in the Lower Willamette Subbasin outside of the Portland Service Area is only 3.7 mgd. In general, adequate supplies are available to satisfy present needs.

Industrial

The industrial water requirement in the Lower Willamette Subbasin is 101.5 mgd. The principal industrial water users are the pulp and paper, primary metals, food products, and miscellaneous industries. These industries have average water needs of about 76.6, 7.1, 5.8, and 6.3 mgd, respectively. Minor industrial water uses are for lumber and wood products and chemical products.

Industrial water use is primarily for pulp and paper production at Oregon City. At the Oregon City Falls, a sulfite and groundwood process mill requires approximately 10.5 mgd of water from the Willamette River. About one-half of this water is treated for use as process water, and the remainder is used for non-process purposes such as fluming. An additional quantity of water is used nonconsumptively for power generation. A plant at West Linn produces newsprint and printing paper from sulfite and groundwood processes, and meets its water requirements by treating approximately 39.5 mgd from the Willamette River. Pulp and paper mills at St. Helens utilize about 28.8 mgd from Multnomah Channel. One mill provides complete treatment, the other mill provides no treatment.

Other industrial uses in the Lower Willamette Subbasin are individually smaller but nevertheless important in aggregate water use. In some instances, industry finds it more economical to purchase water from a municipal system for boiler use than to treat surface supplies.

A substantial but not completely quantitated amount of ground water is used for industrial purposes in the area along the lower reach of the main stem Willamette River, as well as the main stem Columbia River. The uses include heating and cooling, process water in food and kindred plants, fabricating plants, concrete plants, and a host of other uses. The largest individual water user is the primary metals industry at Troutdale. This plant, supplied by 14 wells, has an average water need of about 6.6 mgd. The largest portion of the water (75 to 80 percent) is used for scrubbing stack gases, and the remainder is used for various purposes such as cooling bearings, casting, and cleanup.

Rural-Domestic

Approximately 60,800 persons, or only 7.5 percent of the Lower Willamette Subbasin's population, are served by individual water systems. This portion of the population has an annual water need of about 3.7 mgd. In general, adequate ground- or surface-water sources have been developed for water supplies.

FUTURE NEEDS AND MEANS TO SATISFY NEEDS

At present, 41 percent of the 370.9 mgd municipal, industrial, and rural-domestic water need in Subregion 9 is used for municipal purposes, 54 percent is used by industries, and 5 percent is used for rural-domestic purposes. In the future, the need for municipal water supply is expected to increase faster than the

requirement for either industrial or rural-domestic supplies. By 2020, the municipal demand is expected to utilize 64 percent of the 1,441 mgd projected need. Industrial use will decrease to 33 percent of the total requirement, and the rural-domestic demand will decrease to 3 percent. Total demand is expected to more than triple by 2020.

The estimated population of 1,338,900 in 1965 is projected to increase to 3,591,000 by 2020. This represents an increase of 170 percent, compared with a regional increase of 121 percent. By 2020, 84 percent of the subregional population will be concentrated in the four major service areas.

Production of the major water-using industries is projected to double between now and 2020 in terms of dollar value. It is anticipated that food and chemical products will continue to be the major water-using industries between now and 2020, although establishment of a significant pulp and paper production facility is likely.

In terms of value added, primary metals will become the dominant industry, with food products, pulp and paper, and chemicals also showing significant growth.

Municipal

Basis for Water Supply Projections

The projected population to be served by municipal water systems in 1980, 2000, and 2020 is shown in table 95. By 2020, about 92 percent of the population is expected to be served by central systems. Projected municipal water needs are based on population estimates shown in table 95, and on per capita water requirements presented in (18). Average needs for the subregion are expected to increase from 180 gpcd in 1965 to 205 gpcd in 1980, 225 gpcd in 2000, and 240 gpcd in 2020.

Projections of Water Supply Requirements

Projected municipal water requirements for the years 1970, 1980, 2000, and 2020 are shown in table 96 by subbasin and service area. By 2020, almost 91 percent of the subregion's municipal water needs are expected to occur in the four service areas of Portland, Eugene-Springfield, Salem, and Albany-Corvallis. The balance of the requirements will be scattered throughout the subregion, with towns such as St. Helens, Newberg, Cottage Grove, and McMinnville requiring significant amounts. All persons within

Table 95 - Projected Population. Subregion 9

	1980	2000	2020
	Thousands		
Upper Willamette Subbasin	282.5	390.0	564.0
Eugene-Springfield Service Area	212.4	301.5	438.9
Municipal	198.7	288.0	426.5
Rural	13.7	13.5	12.4
Other	70.1	88.5	125.1
Municipal	30.7	50.5	90.2
Rural	39.4	38.0	34.9
Subtotal	282.5	390.0	564.0
Municipal	229.4	338.5	516.7
Rural	53.1	51.5	47.3
Middle Willamette Subbasin	437.7	556.0	729.0
Albany-Corvallis Service Area	98.7	143.5	210.5
Municipal	98.7	143.5	210.5
Rural	---	---	---
Salem Service Area	160.7	222.5	311.6
Municipal	160.7	222.5	311.6
Rural	---	---	---
Other	178.3	190.0	206.9
Municipal	87.6	107.7	134.6
Rural	90.7	82.3	72.3
Subtotal	437.7	556.0	729.0
Municipal	347.0	473.7	656.7
Rural	90.7	82.3	72.3
Lower Willamette Subbasin	1,047.3	1,476.0	2,298.0
Portland Service Area	939.2	1,320.2	2,065.5
Municipal	939.2	1,320.2	2,065.5
Rural	---	---	---
Other	108.1	155.8	232.5
Municipal	20.0	32.3	52.3
Rural	88.1	123.5	180.2
Subtotal	1,047.3	1,476.0	2,298.0
Municipal	959.2	1,352.5	2,117.8
Rural	88.1	123.5	180.2
Total Subregion	1,767.5	2,422.0	3,591.0
Municipal	1,535.6	2,164.7	3,291.2
Rural	231.9	257.3	299.8

Table 96 - Projected Municipal Water Use, Subregion 9

	1970	1980	2000	2020
		MGD		
Upper Willamette Subbasin				
Eugene-Springfield Service Area	25.2	40.7	64.8	102.4
Other	3.6	6.5	11.4	21.8
	28.8	47.2	76.2	124.2
Middle Willamette Subbasin				
Albany-Corvallis Service Area	12.2	20.3	32.5	50.5
Salem Service Area	20.8	32.6	50.1	74.6
Other	10.9	18.3	24.4	32.5
	43.9	71.2	107.0	157.6
Lower Willamette Subbasin				
Portland Service Area	134.2	203.8	316.7	529.2
Other	4.9	7.4	12.5	21.7
	139.1	211.2	329.2	550.9
Total	211.8	329.6	512.4	832.7

the major service areas will be served by public water systems by the end of the projection period. At that time, 757 mgd will be required in the four service areas, 21.8 mgd will be required by other municipalities in the Upper Willamette Subbasin, 32.5 mgd will be required by communities in the Middle Willamette Subbasin, and 21.7 mgd will be required in the Lower Willamette Subbasin.

Industrial

Basis for Water Supply Projections

All projections of industrial water use are derived from data presented in the Type 2 Study (18). In that study, the growth indices for all industries except the pulp and paper industry were derived from industrial growth projections contained in the study's economic appendix. Projections for the pulp and paper industry were based on projected productivity established by the Columbia-North Pacific Region Framework Study and on reduced water use rates compiled in The Cost of Clean Water, Federal Water Pollution Control Administration, January 10, 1968. (14A)

Projections of Water Supply Requirements

Projected water needs by major industrial categories are presented in table 97 for the years 1970, 1980, 2000, and 2020. By 2020, industrial needs will be about 571.2 mgd, or 40 percent of the total water needs in the subregion.

Table 97 - Projected Industrial Water Use, Subregion 9

	1970	1980	2000	2020
	MGD			
Pulp and paper	132.9	141.3	190.0	215.3
Lumber and wood products	34.0	37.0	31.8	30.6
Food products	19.6	26.8	38.2	55.0
Primary metals	9.9	12.1	17.5	22.4
Chemical products	10.2	16.7	43.1	82.2
Others	15.3	28.2	62.1	165.7
Total	221.9	262.1	382.7	571.2

Rural-Domestic

Basis for Water Supply Projections

Future water needs for domestic use in rural areas are based on an average annual per capita use figure applied to the projected rural population shown in table 95. Per capita domestic water use was assumed to be about 50 percent of that used in nearby municipalities at present.

Projections of Water Supply Requirements

Anticipated rural-domestic water requirements are presented in table 98 by subbasin for the years 1970, 1980, 2000, and 2020. The 1970 usage figure of 18.5 mgd is expected to increase to 36.9 mgd by 2020, with the growth concentrated in the Middle Willamette Subbasin. Approximately 22 percent of the 2020 usage will be required for livestock. Projected total rural-domestic water use data was derived from data in Reference 18. Projected livestock population in the subregion is based on data presented in Appendix VI. It has been assumed, for purposes of this study, that the water use per animal will remain constant during the projection period.

Table 98 - Projected Rural-Domestic Water Use, Subregion 9 (18)

	1970	1980	2000	2020
	MGD			
Upper Willamette Subbasin				
Domestic	3.4	4.5	4.9	4.1
Livestock	0.7	0.8	1.1	1.5
	4.1	5.3	6.0	5.6
Middle Willamette Subbasin				
Domestic	6.5	6.1	5.7	4.7
Livestock	2.5	2.9	3.8	5.0
	9.0	9.0	9.5	9.7
Lower Willamette Subbasin				
Domestic	3.9	7.1	12.0	18.7
Livestock	1.5	1.7	2.2	2.9
	5.4	8.8	14.2	21.6
Total				
Domestic	13.8	17.7	22.6	27.5
Livestock	4.7	5.4	7.1	9.4
	18.5	23.1	29.7	36.9

Problems

The steadily mounting need for municipal and industrial water will not tax the abundant water resources of the Willamette Subregion during the period of study, but localized supply difficulties are certain to emerge. Additional storage capacity must be developed for water supply purposes. The coincidence of peak requirements with summer low-flow periods makes increased storage for water supply purposes a fast-approaching necessity. A substantial portion of the need for storage could be met by Federal multi-purpose reservoirs.

Storage Reservations

Under the provisions of the Water Supply Act of 1958 (P.L. 500), as amended, space may be reserved, on a reimbursable basis, in Federal reservoirs to supply municipal and industrial water requirements. Effectiveness of the Act, however, is limited by the inability of most municipalities and industries to estimate their long-term water supply needs during the planning phase of Federal projects. Legislation enabling the State of Oregon to

request storage on behalf of the ultimate municipal and industrial users would do much to insure that growing water supply needs are met as required for potential Willamette Basin users. This would also provide economies by meeting municipal and industrial water supply requirements from reservoirs concurrently used for other purposes.

Source Identification

Availability of water is a major factor in future source identification. Determination of physically and legally available flow in most watershed areas is not possible at present. Gaging facilities in the upper reaches of most streams are nonexistent. Withdrawals authorized under State water rights may be identified but are not descriptive of the actual water withdrawn. Installation of gaging facilities would cost approximately $5,000 per station for installation and $1,600 annually for operation and maintenance. Adjudication of water rights within each minor basin is also expensive. The Office of the State Engineer has estimated that it would cost about $1.5 million to complete adjudication of water rights in the Willamette Basin.

It is difficult to identify future source developments by location. Civic pride and aesthetics have been inseparable major factors of source selection and have at various times over the years overruled economics as the deciding factor.

Watershed Management

A major problem that faces several purveyors, but mainly Portland, concerns possible future changes in management of their limited-use watersheds to permit additional uses and the associated need for water treatment. Many considerations, including strongly held public opinions, are involved. Since complete treatment of water from controlled-use watersheds is not now required by the Oregon State Board of Health, the cost of water to the consumer is also significantly affected. Research is adding to the basic information on the public health aspects of multiple use of watershed lands and reservoirs used for municipal supply. Other problems, however, call for assessment of rather complex economic and social benefits of multiple use. These considerations are important in our present society because people are willing to pay not only for basic needs and protection from injury, disease, and death, but for basic aesthetics as well. It is important, then, that multiple-use decisions take cognizance of both tangible and intangible benefits, which determine true economic feasibility. On one hand, recreation is,

and will continue to be, one of the major water and related land uses. On the other hand, the residential water user has a strong desire to have a source of supply free of pollution and as close to its pristine state as possible.

Compatible uses of municipal water supply reservoirs and watersheds should be carefully controlled to assure the best quality of the public raw water sources. In areas where a recreational deficit does not exist, single-purpose reservoirs should be held in reserve and restricted to the single-purpose water supply use until such time as it becomes necessary to use them to satisfy definitive recreation demand, where economically justified and financially feasible.

Demand Growth

Increased requirements for municipally supplied water may be measured by a per capita demand increase as well as by an increase in the number of persons served. The number of persons served is increasing at a more rapid rate than the population because local ordinances require public water supplies for new housing developments, and because a reliable supply of safe water for household use is needed in established suburban areas. In some suburban areas, each household is served by individual subsurface waste disposal and water supply until increased housing density and ground-water pollution or contamination become critical. Then the people residing in the area must either form a legal body such as a water district to operate a public water system or annex to an adjacent community for municipal services. In some places, county or city land-use control agencies recognize an area as unsuitable for individual water supply and will not permit development until a public water system is assured.

Industrial use of municipally supplied water is also increasing, primarily for economic reasons. Some industries have found it to be less expensive to purchase finished water than to develop an individual water system. The largest industrial user of municipally supplied water is the food-processing industry. By the nature of this industry, it is essential that large amounts of high quality water be available.

Solutions

In most of the Willamette Subregion, municipal and industrial water supplies may be derived from ground water, surface water, or a combination. Surface-water sources may require storage for regulation during summer low-flow periods. The individual

selection of the source depends upon an evaluation of several factors, chief among which are cost, adequacy of supply, and aesthetic considerations.

The supply of water within the Willamette Subregion, on an annual basis, is adequate for existing and projected municipal and industrial requirements. Some systems do experience short-term shortages, due to seasonal streamflow deficiencies, and transmission and treatment limitations, but these can be overcome. Smaller communities normally have the most difficulty in meeting water supply needs. Most physical water supply problems within the subregion may be solved by storage, transmission, or treatment, but small communities are seldom able to finance the required improvements.

Three major steps will have to be taken in order to satisfy future municipal demands: (1) In some cases, water in upstream or out-of-basin storage must be acquired--preferably from a multipurpose development for use during periods of low natural streamflow. (2) Transmission line and distribution storage capacity must be sized to satisfy peak demands without imposing excessive hourly or daily withdrawals from the source. (3) People must become willing to accept streams now considered to be of poor quality as a water source; treatment plants will be required. Use of reclaimed waste water may also occur in the future. Historically, the voters of Salem and Eugene have shown a willingness to pay a premium for water from a river of higher apparent quality rather than to treat water from the Willamette River, a more conveniently located stream, to the same finished standards.

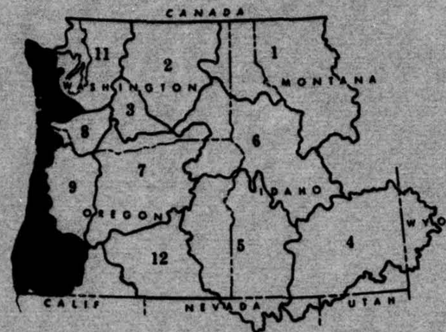
Water treatment practices vary at the present time, but it should be assumed that all surface water will be subject to complete purification at some time in the future.

In most instances, the precise amount of stored water required for a given user is not easily identifiable, because only a few of the Willamette River tributary streams have been adjudicated, and the status of existing rights is not certain. Present water use under power claims in places such as Lebanon, Albany, Salem, and Oregon City clouds the issue even further.

Ground water is used in large quantities, primarily for heating or cooling, but not for the more common municipal and industrial uses. Both the quantity available and the quality of ground water vary throughout the subregion, and only a small part of the population now relies on ground water as a source of supply. In the future, ground water will become a major source

of supply for only a limited number of people. However, many of the smaller communities can adequately meet their needs for many years to come by continued use of ground water.

Along the Willamette Valley floor, some of the small, contiguous communities should consider inter-municipal systems. Planning funds and construction loans are available from the Farmers Home Administration for such development. However, as long as individual community ground-water supplies can be utilized, the greater expense of an integrated system using surface water with attendant water purification facilities will not be financially attractive.



LOCATION MAP

SUBREGION

10

SUBREGION 10

COASTAL

INTRODUCTION

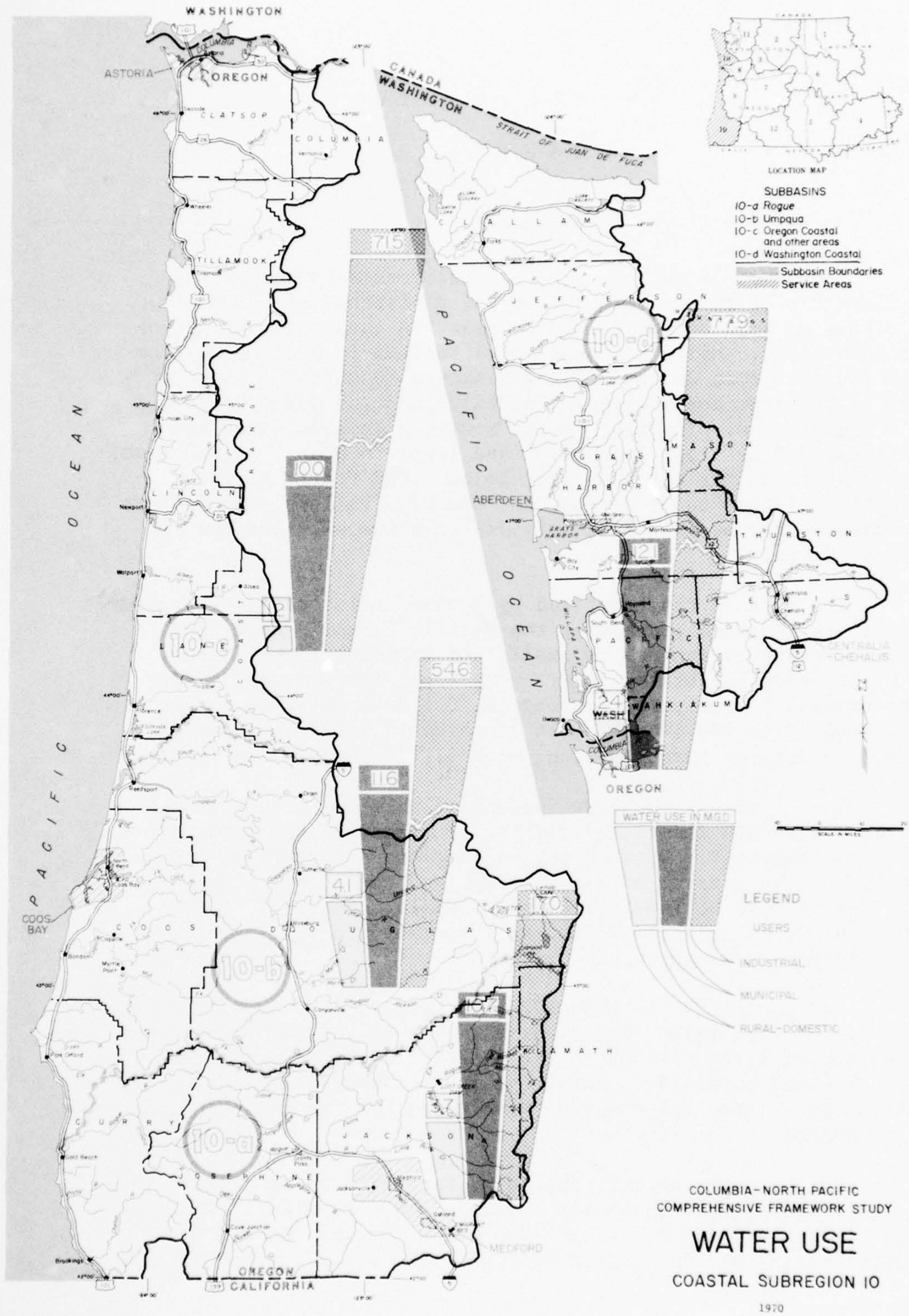
Subregion 10 extends from the California border to the northern tip of the Olympic Peninsula, a distance of 500 miles. It covers an area of 23,763 square miles in the states of Oregon and Washington. Hilly to mountainous terrain is continuous from the Strait of Juan de Fuca to the Siskiyou Mountains. About one-half of the snowcapped Olympic Mountains and the Coast Range are in the subregion, plus part of the southern Cascade Range and Siskiyous. Elevations range from sea level to nearly 10,000 feet, although elevations are generally below 3,000 feet. With the exception of the Rogue, Umpqua, and Chehalis Valleys, the valleys are usually narrow, widening only within a few miles of the Pacific Ocean.

The area is characterized by a mild, moist climate. Temperatures are modified greatly by the Pacific Ocean. Hourly and daily temperature ranges are small, and extremes rarely occur. With the exception of the interior valleys, temperatures seldom drop below 0°F. and rarely exceed 100°F. Precipitation totals vary from 20 to 200 inches, most of which falls in the form of rain from October through March, with little in July and August.

The principal economic force is timber harvesting and processing, although commercial fishing, recreation, and agriculture also are important. Outstanding recreational attractions abound throughout the coastal areas of Oregon and Washington. Beginning with the Olympic National Park and extending southward to the southern Oregon beaches are the most popular and well-developed recreational resources of the region.

The population is about 425,800 people, of whom 41 percent live in the five major service areas. The larger towns are generally located along bays or in the interior along major streams. There is much rural land, resulting in an overall low density of settlement. Along the coast of Washington are six small Indian reservations.

For purposes of this appendix, Subregion 10 is divided in terms of significant subbasins and major service areas. The four major subbasins (figure 11) are the Rogue, Umpqua, Other Oregon Coastal Areas, and Washington Coastal. The major service areas



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

WATER USE

COASTAL SUBREGION 10

1970

FIGURE 11

are the Medford, Coos Bay, Astoria, Chehalis-Centralia, and Aberdeen areas. These service areas represent about one-third of the subregion's total population.

Table 99 - Present Municipal, Major Industrial, and Rural-Domestic Water Supply Needs, Subregion 10

	Municipal	Industrial	Rural-Domestic	Total	% Total Sub-region
	MGD				
Rogue Subbasin					
Medford Service Area	7.9	15.4	-	23.3	8.4
Other	2.8	1.6	3.7	8.1	2.9
	10.7	17.0	3.7	31.4	11.3
Umpqua Subbasin					
Coos Bay Service Area	3.7	29.4	-	33.1	12.0
Other	7.9	25.2	4.1	37.2	13.4
	11.6	54.6	4.1	70.3	25.4
Other Oregon Coastal Areas Subbasin					
Astoria Service Area	2.6	1.6	-	4.2	1.5
Other	7.4	69.9	1.2	78.5	28.4
	10.0	71.5	1.2	82.7	29.9
Washington Coastal Subbasin					
Aberdeen Service Area	5.2	74.0	-	79.2	28.6
Chehalis-Centralia Service Area	2.6	1.5	-	4.1	1.5
Other	4.3	2.4	2.4	9.1	3.3
	12.1	77.9	2.4	92.4	33.4
Total	44.4	221.0	11.4	276.8	100.0

PRESENT STATUS

Table 99 summarizes the municipal, major industrial, and rural-domestic water use for the subbasins and service areas. At present, the requirement averages about 277 mgd, including a municipal demand of 44.4 mgd, an industrial demand of 221.0 mgd, and a

rural-domestic demand of 11.4 mgd. The distribution of this need shows that use is concentrated in the Aberdeen, Coos Bay, and Medford Service Areas. These areas require about 28, 12, and 8 percent, respectively, of the subregion's average annual water requirement.

About two-thirds of the population is served by municipal water systems. Approximately 75.3 percent of the systems depend on surface-water sources, 19.3 percent on ground-water sources, and 5.4 percent on mixed supplies.

The principal industrial water use is for pulp and paper production, which requires 148.6 mgd, or 67 percent of the total industrial need. Other significant industrial uses are for the lumber and wood products and the food products industries, which require 51.8 and 6.5 mgd, respectively.

Table 100 summarizes a generalized variation in need for municipal water use in the subregion. Since no data concerning the municipal monthly pattern are available, a statistical analysis of water supply distribution for similar areas in the Pacific Northwest was used to derive the figures. These data show that generally the maximum municipal need occurs in the month of August. June, July and September are also high-use months. With the exception of the food products industry, little seasonal variation in industrial water use occurs.

Table 100 - Monthly Variation in Water Needs, Subregion 10

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	Percent											
Municipal	77	89	77	91	86	111	123	138	113	97	78	89
Industrial	No data available											

Water Quality

Surface Water

The quality of surface waters used for municipal and industrial supply may be generally described as good. The primary constituents that must be removed or treated before use, in addition to disease-producing organisms, are sediment, and taste- and odor-producing bilogical growths.

The mineral quality of surface waters is generally quite acceptable. Only the waters in tide-affected reaches would require mineral removal before use as a municipal or industrial supply. The streams usually contain calcium bicarbonate type waters,

although streams draining the Klamath Mountains contain high percentages of magnesium ion. Dissolved solids range from 30 to 90 mg/l and average less than 50 mg/l in all streams except the Rogue River. The dissolved solids concentration in the upper reaches of the Rogue is about 60 mg/l. There is some downstream mineralization resulting in maximum dissolved solids concentrations of 90 mg/l at Merlin. The mineral character in the lower reaches of most streams on the coast is affected by saltwater intrusion. In the Siuslaw River high chloride and sodium concentrations, indicative of saltwater intrusions, have been found as far as 20 miles upstream from the mouth.

Most streams periodically exhibit excessive sediment concentration as a result of high runoff or mining, logging, or road construction operations. Also, streams that drain the Olympic Mountains are sometimes very turbid with glacial flour.

Taste and odor problems associated with algal growths occur seasonally in the inland areas of the Rogue, Umpqua, and Chehalis Rivers. The problems are generally most evident during the summer low streamflow period. The occurrence of obnoxious biological organisms results in higher treatment costs and a decrease in palatability in the absence of control.

The bacterial quality of most streams in the subregion is adequate for most municipal purposes with disinfection only. Coliform densities which would require additional treatment generally occur only below major service areas. Most notable cases of bacterial pollution are in the Chehalis River below Chehalis, in the South Umpqua River below Roseburg, and in the Rogue River below Grants Pass. High bacterial concentrations occur in several estuaries, which, however, are not used for municipal water supply purposes.

Table 101 presents a summary of water quality parameters important to water use for selected surface waters.

Ground Water

The mineral quality of ground-water supplies for selected communities is listed in table 102. The quality is generally adequate for most municipal and industrial purposes. Salinity and excessive iron content are the most common problems which have been encountered in the use of ground water.

Table 101 - Summary of Water Quality Data for Surface Water, Subregion 10

	River Mile	D.O. (mg/l)	T (°C)	Coliform MPN/ 100ml	pH	Color (PT-CO Units)	Hard. (mg/l)	Turb. (JTU)	TDS (mg/l)	Ortho PO_4 (mg/l)	NO_3-N (mg/l)
Rogue River near Prospect, Ore.	164.1										
Mean		11.1	8.3	420	--	--	--	4	--	0.11	0.03
Min.		9.0	2.0	6	--	--	--	0	--	0.01	0.02
Max.		13.0	14.0	6,200	--	--	--	12	--	0.21	0.31
No. of samples		31	32	30	--	--	--	33	--	33	33
Bear Creek at Ashland, Ore.	126.8-22.4										
Mean		10.3	12.4	3,400	--	--	--	23	--	0.24	0.16
Min.		6.8	1.0	45	--	--	--	12	--	0.10	0.01
Max.		13.5	25.0	7,000	--	--	--	45	--	0.36	0.40
No. of samples		39	39	37	--	--	--	5	--	5	5
Bear Creek near Central Point, Ore.	126.8-3.8										
Mean		10.4	14.6	31,000	--	--	--	35	--	0.54	0.32
Min.		7.0	4.0	62	--	--	--	5	--	0.01	0.01
Max.		13.8	31.0	>70,000	--	--	--	90	--	1.30	1.33
No. of samples		33	34	32	--	--	--	22	--	33	33
Rogue River at Grants Pass, Ore.	101.3										
Mean		11.2	13.3	3,700	--	--	--	5	--	0.22	0.15
Min.		9.1	2.0	130	--	--	--	1	--	0.19	0.01
Max.		13.5	25.0	24,000	--	--	--	6	--	0.31	0.33
No. of samples		32	33	29	--	--	--	5	--	5	5
Rogue River at Merlin, Ore.	86.0										
Mean		11.1	13.7	4,670	--	--	--	5	--	0.16	0.08
Min.		9.1	4.0	5	--	--	--	0	--	0.01	0.01
Max.		12.7	25.5	77,000	--	--	--	27	--	0.27	0.85
No. of samples		32	33	32	--	--	--	33	--	34	34
S. Fork Coquille R. near Powers, Ore.	27.2										
Mean		11.1	13.4	2,996	--	--	--	4	--	0.05	0.03
Min.		8.7	3.0	23	--	--	--	0	--	0.00	0.00
Max.		14.1	26.0	7,000	--	--	--	35	--	0.22	0.12
No. of samples		21	22	21	--	--	--	21	--	22	22
South Umpqua River at Days Creek, Ore.	168.9										
Mean		10.3	15.5	189	--	--	--	12	--	0.10	0.04
Min.		8.6	4.0	5	--	--	--	0	--	0.00	0.00
Max.		12.7	28.0	700	--	--	--	76	--	2.09	0.14
No. of samples		36	37	36	--	--	--	39	--	37	31
Cow Creek below Riddle, Ore.	158.9-1.3										
Mean		10.5	16.4	5,142	--	--	--	2	--	0.12	0.02
Min.		8.4	5.0	60	--	--	--	1	--	0.01	0.01
Max.		12.6	27.5	24,000	--	--	--	4	--	0.19	0.05
No. of samples		20	21	20	--	--	--	4	--	4	4
South Umpqua River at Melrose Road	118.8										
Mean		10.3	16.3	12,634	--	--	--	12	--	0.21	0.09
Min.		6.3	5.0	450	--	--	--	0	--	0.01	0.01
Max.		12.3	27.0	70,000	--	--	--	80	--	0.73	0.44
No. of samples		36	36	36	--	--	--	37	--	39	39
North Umpqua River at Lone Rock Bridge	111.7-31.1										
Mean		11.1	12.6	84	--	--	--	8	--	0.08	0.04
Min.		9.2	4.0	6	--	--	--	0	--	0.00	0.00
Max.		13.0	20.0	240	--	--	--	61	--	0.40	0.12
No. of samples		36	37	35	--	--	--	39	--	39	39
Umpqua River at Elkton, Ore.	48.6										
Mean		10.2	16.6	970	--	--	--	12	--	0.05	0.02
Min.		8.3	5.0	6	--	--	--	0	--	0.00	0.01
Max.		12.5	26.0	7,000	--	--	--	85	--	0.38	0.04
No. of samples		36	37	35	--	--	--	39	--	39	39
Siuslaw River at Mapleton, Ore.	20.5-21.0										
Mean		9.6	13.8	610	--	--	--	3	--	0.03	0.10
Min.		5.2	1.0	130	--	--	--	0	--	0.01	0.01
Max.		13.2	23.0	2,400	--	--	--	20	--	0.11	0.35
No. of samples		26	28	26	--	--	--	24	--	22	22
Siletz River near Siletz, Ore.	30.9-31.5										
Mean		10.4	13.1	350	--	--	--	3	--	0.02	0.12
Min.		8.1	2.0	23	--	--	--	0	--	0.01	0.01
Max.		13.2	20.0	2,400	--	--	--	10	--	0.12	0.40
No. of samples											
Nehalem River Station 1130	7.3										
Mean		10.9	11.8	290	--	--	--	5	--	0.07	0.14
Min.		8.0	1.5	13	--	--	--	0	--	0.01	0.00
Max.		13.4	21.0	700	--	--	--	20	--	0.65	0.58
No. of samples		24	24	23	--	--	--	24	--	23	24
Wilson River Station 1165	8.5										
Mean		12.0	12.1	140	--	--	--	3	--	0.04	0.05
Min.		7.3	5.0	5	--	--	--	0	--	0.01	0.01
Max.		12.9	20.0	700	--	--	--	20	--	0.17	0.14
No. of samples		25	27	25	--	--	--	24	--	24	24

Table 101 (Continued)

	River Mile	D.O. (mg/l)	T (°C)	Coliform MPN/ 100ml	pH	Color (PT-CO) Units	Hard. (mg/l)	Turb. (JTU)	TDS (mg/l)	Ortho PO_4 (mg/l)	NO_3-N (mg/l)
Bear River near Naselle, Wash.											
Mean		10.3	10.6	446	6.9	--	14	--	43	--	0.4
Min.		8.8	5.9	0	6.3	5	8	--	34	--	0.1
Max.		11.7	15.5	4,600	7.2	20	18	--	52	--	0.6
No. of samples											
Naselle River near Naselle, Wash.											
Mean		11.2	11.8	180	7.2	--	16	--	41	--	0.8
Min.		9.1	5.1	0	6.7	5	11	--	37	--	0.1
Max.		14.0	18.9	930	7.6	10	20	--	48	--	1.7
No. of samples											
Willapa River at Willapa, Wash.											
Mean		10.5	12.6	676	7.0	--	17	--	48	--	1.2
Min.		8.1	5.3	36	6.4	5	10	--	35	--	0.1
Max.		13.2	20.8	4,600	7.5	15	23	--	64	--	3.2
No. of samples											
Chehalis River near Doty, Wash.											
Mean		10.9	10.8	563	7.1	--	20	--	50	0.03	0.6
Min.		7.6	2.0	0	6.7	5	14	0	39	0.00	0.1
Max.		13.8	22.6	4,600	7.6	20	27	50	62	0.17	1.4
No. of samples											
Chehalis River at Porter, Wash.											
Mean		10.4	12.5	1,213	7.1	--	23	--	56	0.06	0.9
Min.		7.2	3.3	0	6.7	0	12	0	35	0.00	0.1
Max.		12.8	23.4	24,000	7.6	30	36	40	80	0.14	2.0
No. of samples											
Cloquallum River at Elma, Wash.											
Mean		10.5	10.9	2,840	7.1	--	22	--	51	0.04	1.4
Min.		4.8	4.9	36	6.6	5	12	0	38	0.00	0.5
Max.		12.5	20.2	24,000	7.8	30	29	25	67	0.13	3.7
No. of samples											
Satsop River near Satsop, Wash.											
Mean		10.9	11.8	145	7.2	--	21	--	46	0.02	0.4
Min.		5.3	5.1	0	6.8	0	12	0	33	0.00	0.1
Max.		12.8	20.1	2,400	7.6	20	28	180	55	0.04	1.2
No. of samples											
Wynoochee River near Montesano, Wash.											
Mean		10.8	11.2	113	7.2	--	23	--	41	0.01	0.4
Min.		6.9	4.8	0	6.8	0	14	0	28	0.00	0.0
Max.		13.8	22.3	930	7.7	20	42	250	58	0.03	1.3
No. of samples											
Humptulips River near Humptulips, Wash.											
Mean		10.9	10.8	78	7.2	--	21	--	41	0.01	0.3
Min.		9.0	4.9	0	6.7	0	13	0	29	0.00	0.0
Max.		12.9	22.0	430	7.6	20	27	150	52	0.08	2.2
No. of samples											
Quinault River at Quinault Lake, Wash.											
Mean		10.6	10.0	20	7.1	--	25	--	38	0.01	0.2
Min.		9.2	5.6	0	6.8	0	22	0	32	0.00	0.0
Max.		13.0	17.8	230	7.4	10	42	15	51	0.06	0.5
No. of samples											
Queets River at Queets, Wash.											
Mean		11.1	10.3	86	7.1	--	23	--	40	0.01	0.3
Min.		9.2	4.2	0	6.4	0	10	0	26	0.00	0.0
Max.		12.9	20.0	430	7.5	80	30	400	49	0.04	1.4
No. of samples											
Hoh River near Forks, Wash.											
Mean		11.3	8.9	87	7.3	--	29	--	46	0.01	0.2
Min.		10.2	4.0	0	6.6	0	10	0	28	0.00	0.0
Max.		13.2	17.0	930	7.6	25	35	300	53	0.05	0.6
No. of samples											
Soleduck River near Fairholm, Wash.											
Mean		11.3	9.4	28	7.5	--	31	--	46	0.01	0.1
Min.		9.2	3.4	0	7.0	0	16	0	27	0.00	0.0
Max.		13.7	18.8	360	7.9	15	43	35	58	0.04	0.3
No. of samples											

Table 102 - Mineral Water Quality of Ground-Water Supplies, Subregion 10

		SiO_2	Fe	Ca	Mg	Na	HCO_3	SO_4	Cl	NO_3	Total Solids	Hard. $CaCO_3$	F	pH
		mg/l												
Medford, Oregon	10/9/53	34	0.14	7.6	4.6	6.5	43	3.7	5.1	0.05	87	38	0.0	6.9
Tillamook, Oregon	8/26/58	40	0.27	30.1	11.3	11.7	121	0.9	7.2	0.05	192	122	0.0	7.2
Westport, Wash. (Well 2)	5/25/60	24	0.02	9.5	12	21	92	6.0	31	0.7	155	88	0.1	7.6
Elma, Washington	9/20/63	20	0.52	9.9	2.2	2.4	17	2.2	3.5	4.0	53	10	0.02	6.2
Pacific Beach, Wash.	11/7/62	56	0.58	2.0	3.0	15.3	76	2.4	10	1.5	132	18	0.12	6.7
Napavine, Washington	1/11/68	35	0.11	15.2	6.3	6.4	85	2.4	6.5	2.0	136	64	0.1	7.5
Centralia, Wash. (Well 5)	5/31/60	33	3.1*	18	6.1	19	84	7.0	19	6.9	152	70	0.1	7.1
Bucoda, Washington	11/12/59	29	0.04	11	3.3	6.2	50	5.0	4.8	3.8	89	41	0.0	6.7
Forks, Washington	5/2/61	15	0.07	22	3.3	4.3	76	11	3.0	0.4	96	68	0.2	8.1

* Total iron.

The chemical quality of water from aquifer units differs considerably. Water from the younger alluvial aquifers, which furnish most large ground-water supplies, generally has low dissolved solids, seldom exceeding 250 mg/l. The water is most often a soft to moderately hard, calcium-magnesium bicarbonate type. However, high iron concentrations are a problem in many supplies. The water in the older volcanic or sedimentary aquifer units is more highly mineralized, although the dissolved solids level is usually less than 500 mg/l. In addition, water at depth in the sedimentary units is commonly saline, but saline water is encountered at some places within 100 feet of the surface. The volcanic and sedimentary aquifers are extensively used for domestic or small public and industrial purposes.

Treatment

A summary of municipal water treatment practices in Subregion 10 is presented in table 103. Mineral removal and specialized treatment are not listed. Communities utilizing mixed or surface supplies generally provide at least disinfection before distribution. Municipalities in the Oregon portion of the subregion withdrawing from major streams often operate complete treatment facilities (chemical coagulation, sedimentation, rapid sand filtration, and chlorination). Few municipalities in Washington practice complete treatment. Less than one-half of the communities relying on underground sources disinfect water supplies.

Table 103 - Summary of Municipal Water Sources and Treatment Practices, Subregion 10

Source	Number of Municipal Facilities	Population Served Thousands	Percent of Total Population
Surface			
No treatment	2	0.7	0.3
Disinfection	49	123.3	43.6
Complete	19	88.7	31.4
	70	212.7	75.3
Ground			
No treatment	16	9.1	3.2
Disinfection	12	45.6	16.1
Complete	--	--	--
	28	54.7	19.3
Mixed			
No treatment	2	1.3	0.5
Disinfection	10	10.3	3.6
Complete	2	3.6	1.3
	14	15.2	5.4
Total	112	282.6	100.0

Rogue Subbasin

Municipal

Approximately 67,400 persons, or 59 percent of the Rogue Subbasin's population, are served by municipal water systems. The municipal population has an average annual water requirement of about 10.7 mgd. Nearly three-fourths of the demand is concentrated in the Medford area.

The Medford Service Area, which includes Medford, Ashland, Talent, Phoenix, Jacksonville, Central Point, and Eagle Point, has an average municipal water requirement of about 7.9 mgd. The City of Medford obtains its supply from Big Butte Springs. The communities of Jacksonville, Central Point, and Eagle Point and several small water districts in the area withdraw from the Medford system. Ashland and Talent use surface water for their sources of supply. These communities provide coagulation, filtration, and chlorination facilities to treat for high turbidities and high coliform densities that occur during portions of the year.

Outside of the Medford Service Area, the City of Grants Pass, which requires 1.55 mgd, has the largest water need. The water withdrawn from the Rogue River by Grants Pass receives complete treatment before distribution. The communities of Gold Hill and Gold Beach also obtain water from the Rogue River. With the exception of Brookings, most of the other municipalities in the subbasin rely upon underground sources for water supplies.

Industrial

The industrial water requirement in the Rogue Subbasin is about 17.0 mgd. The principal water users are the chemical products and the lumber and wood products industries, which need 11.1 and 5.3 mgd, respectively. Over 90 percent of the requirement is centered in the Medford Service Area.

In the Medford Service Area, industries use about 15.4 mgd. Industrial Air Products is the largest individual water user, requiring about 11.0 mgd. Sawmills and plywood and veneer mills in the service area have a combined water requirement of about 4.1 mgd. The food products industry is a minor water user in the service area.

The lumber and wood products industry is the major water user in the remainder of the Rogue Subbasin. Forest products mills at Grants Pass and Brookings have needs of about 0.7 and 0.8 mgd, respectively.

Rural-Domestic

Approximately 46,700 persons, or 34 percent of the Rogue Subbasin's population, are served by individual water systems and have an average requirement of about 3.7 mgd.

Domestic water needs are generally satisfied by pumping from individual wells.

Umpqua Subbasin

Municipal

About 72,600 persons, or 58 percent of the subbasin's population, are served by municipal water facilities. Municipalities have an average annual water requirement of 11.6 mgd. Over half of the need is centered in the Coos Bay Service Area and the Roseburg area.

The Coos Bay Service Area, which includes Coos Bay, North Bend, Eastside, and Empire, has a municipal water requirement of about 3.7 mgd. These communities are served by the Coos Bay-North Bend Water Board. The source of supply is the Pony Creek watershed area. At present, an adequate supply of excellent quality water is available for municipal purposes.

The present water requirement in the Roseburg area is 2.1 mgd. The city obtains its water from the North Umpqua River. Several urban areas in the vicinity of Roseburg, including the Roberts Creek, Winston-Dillard, and Tri-City Water Districts, utilize the South Umpqua River for their source of supply. In general, most of these systems provide complete conventional treatment because of seasonal turbidity, color and odor problems, and bacterial contamination. Other communities in the general vicinity of Roseburg depend upon creeks for their water supplies.

The Reedsport area and several communities in the Coquille River drainage also have significant water needs. About 0.7 mgd is required for municipal purposes in Reedsport and its surrounding urban area. In the Coquille drainage, the communities of Bandon, Coquille, Myrtle Point, and Powers have a combined water need of about 1.9 mgd. The communities generally obtain water from the main stem or the North or South Fork Coquille River and/or small watershed areas. Coquille and Bandon practice complete treatment before distribution.

Industrial

The industrial water requirement in the Umpqua Subbasin is about 54.6 mgd. The principal water users are the lumber and wood products, pulp and paper, and primary metals industries. These industries have average water needs of 28.9, 22.7, and 3.0 mgd, respectively. Over one-half of the need is centered in the Coos Bay Service Area.

The pulp and paper and the lumber and wood products industries in the Coos Bay Service Area have average water requirements of 16.4 and 13.0 mgd, respectively. The largest individual water user is a pulp and paper mill at Empire. This sulfite process mill requires 13.0 mgd. A semi-chemical process pulp mill at North Bend uses about 3.4 mgd for production of liner board. A large plywood and veneer mill at North Bend has a water need of approximately 10.6 mgd. In addition, two plywood mills have water needs of 1.6 and 0.8 mgd, respectively.

The forest products industry accounts for a significant water requirement in the Reedsport area. A paperboard mill at Gardiner has an average water need of about 6.3 mgd, and the plywood mill uses 1.4 mgd. Also, a plywood mill at Reedsport has a requirement of 2.4 mgd.

Major water needs for the lumber and wood products industry also exist along Calapooya Creek, in the vicinity of Coquille, and in the Roseburg and South Umpqua area. These areas have average water needs of approximately 2.7, 4.9, and 2.3 mgd, respectively.

A plant at Riddle has the largest water requirement for a primary metals industry in the subbasin. The operation withdraws an average of about 3.0 mgd from Cow Creek. There are several other mining and sand-and-gravel operations, but data concerning water use are not available.

Rural-Domestic

Approximately 50,100 persons, or 42 percent of the subbasin's population, are served by individual water systems. This portion of the population has an annual average water requirement of 4.1 mgd.

The domestic water need is generally satisfied by withdrawing from small creeks or pumping from individual wells.

Other Oregon Coastal Areas Subbasin

Municipal

In this subbasin, about 65,100 persons, or 81 percent of the total population, are served by municipal water systems and have a need for 10.0 mgd. The largest municipal water use is in the Astoria Service Area, which requires about one-fourth of the total municipal need.

The Astoria Service Area, including Astoria, Warrenton, and Hammond, has an average requirement of 2.6 mgd. The cities of Astoria and Warrenton obtain water from surface sources. The community of Hammond withdraws water from the Warrenton system. The source of supply for Warrenton requires pH adjustment before distribution.

Other municipal water-use centers are the Newport, Lincoln City, Tillamook, and Seaside areas. The municipal requirement in

the Newport area, including Toledo, is about 1.4 mgd. Both communities rely upon surface-water sources. Newport fully treats its supply, and Toledo needs to provide only disinfection. Lincoln City, which includes Oceanlake, Taft, Nelscott, and Delake, uses 1.1 mgd for municipal purposes. All of these communities are served by creeks. Taft, Nelscott, and Delake have formed a common water district. The Tillamook and Seaside areas have water needs of 0.8 and 0.9 mgd, respectively. Both areas are served by surface-water supplies. Turbidity problems at Tillamook are encountered in the present watershed.

Most of the remaining municipalities in the subbasin are served by surface-water sources. Only two small communities rely upon underground sources. Generally, no treatment in addition to disinfection is needed for municipal purposes.

Industrial

The industrial water requirement in the Other Oregon Coastal Areas Subbasin is 71.5 mgd. The principal water user is the pulp and paper industry, which needs 63.0 mgd. The lumber and wood products and the food products industries also account for significant water uses. These industries need 6.3 and 2.2 mgd, respectively.

A sulfate-process pulp and paper mill at Wauna is the largest individual water user. The plant withdraws over 50 mgd from the Columbia River. A pulp and paper mill at Toledo uses about 13.0 mgd. The mill obtains a small quantity of water from the Toledo municipal system, but has a separate water system on Olalla Creek for its primary supply. During low streamflow periods, storage on Olalla Creek is augmented by pumpings from the Siletz River.

There are a number of plywood and veneer mills in the subbasin. The largest are located at Toledo and at Valsetz. These mills require 0.8 and 2.7 mgd, respectively. The remaining forest products plants have a total water requirement of 2.8 mgd.

Water use by the food products industry is centered in the Astoria Service Area and in the Newport and Tillamook areas, which require 1.0, 0.2, and 1.0 mgd, respectively. In general, the industrial water use is supplied by municipal systems.

Rural-Domestic

Approximately 15,100 persons, or 19 percent of the subbasin's population, are served by individual water systems and have an average water requirement of 1.2 mgd.

The source of supply for most individual systems is small creeks or wells.

Washington Coastal Subbasin

Municipal

In this subbasin, approximately 77,800 persons, or 72 percent of the total population, are served by municipal water systems. The municipalities have an annual average water need of 12.1 mgd. Nearly two-thirds of the requirement is centered in the Chehalis-Centralia and Aberdeen Service Areas.

The Aberdeen Service Area, which includes Aberdeen, Hoquiam, and Cosmopolis, has an average water requirement of about 8 mgd. The City of Aberdeen, which obtains its municipal water supply from the Wishkah River, has also constructed intake works on the Wynoochee River capable of diverting 70.5 mgd for industrial use. The community of Cosmopolis uses water from the Aberdeen municipal system. Hoquiam has developed sources on tributaries of the Hoquiam River for municipal supply.

The Chehalis-Centralia Service Area has a municipal water need of 2.6 mgd. The cities of Chehalis and Centralia have each installed intakes on the North Fork Newaukum River for municipal supply. In addition, Centralia has developed several wells to meet peak summertime demands, and Chehalis is also drawing water from the Chehalis River.

The South Bend-Raymond area also represents a significant water-use center. About 0.8 mgd is required for municipal purposes. Surface-water sources are used for each community's supply.

In the remainder of the subbasin, the communities of McCleary, Montesano, Pe Ell, Ilwaco, Long Beach, Quinault, and Oakville use surface-water sources, while many smaller communities utilize ground water sources.

Industrial

The industrial water requirement in the subbasin is about 77.9 mgd. The principal water user is the pulp and paper industry, which needs 62.9 mgd. The lumber and wood products and the food products industries also have significant requirements. These industries use 11.0 and 4.0 mgd, respectively. About 95 percent of the industrial water use is concentrated in the Aberdeen Service Area.

The pulp and paper mills in the Aberdeen Service Area account for 85 percent of the area's industrial water requirement. The mill at Hoquiam is the largest water user, requiring 30.0 mgd. A mill at Cosmopolis utilizes 28.0 mgd, and one at Hoquiam needs 4.9 mgd. The lumber and wood products industry in the service area uses about 8.6 mgd. A plywood and veneer mill at Aberdeen, requiring 4.0 mgd, is the largest user. The food products industry represents a water need of 2.5 mgd. Nearly all of the industries in the service area obtain their water from the City of Aberdeen's industrial supply.

The industrial water need in the Chehalis-Centralia Service Area is 1.5 mgd. The food products industry uses about 1.2 mgd, and the lumber and wood products industry accounts for the remainder.

The lumber and wood products industry is the largest industrial water user outside of the two major service areas. Plywood mills and sawmills at McCleary, Elma, and Raymond use 2.1 mgd. Food products plants at Markham, Westport, and South Bend represent a minor industrial water use.

Rural-Domestic

Approximately 31,000 persons, or 28 percent of the Washington Coastal Subbasin's population, are served by individual water systems. This portion of the population has an average requirement of 2.4 mgd.

Domestic water needs are generally satisfied by pumping from individual wells.

FUTURE NEEDS AND MEANS TO SATISFY NEEDS

The future water needs in Subregion 10 will depend primarily on population growth and industrial expansion. As these increase, the need for water will likewise increase.

Table 104 - Projected Population, Subregion 10

	1980	2000	2020
	--------Thousands--------		
Rogue Subbasin	139.1	183.0	239.4
Medford Service Area	84.2	125.8	180.4
Municipal	65.2	115.5	180.4
Rural	19.0	10.3	---
Other	54.9	57.2	59.0
Municipal	30.6	32.9	34.7
Rural	24.3	24.3	24.3
Subtotal	139.1	183.0	239.4
Municipal	95.8	148.4	215.1
Rural	43.3	34.6	24.3
Umpqua Subbasin	138.1	161.5	192.1
Coos Bay Service Area	40.7	60.6	90.3
Municipal	34.7	57.6	90.3
Rural	6.0	3.0	---
Other	97.4	100.9	101.8
Municipal	55.8	59.3	60.2
Rural	41.6	41.6	41.6
Subtotal	138.1	161.5	192.1
Municipal	90.5	116.9	150.5
Rural	41.6	44.6	41.6
Other Oregon Coastal Areas Subbasin	89.2	110.2	134.6
Astoria Service Area	21.9	29.9	41.6
Municipal	21.9	29.9	41.6
Rural	---	---	---
Other	67.3	80.3	93.0
Municipal	51.4	64.4	77.1
Rural	15.9	15.9	15.9
Subtotal	89.2	110.2	134.6
Municipal	73.3	94.3	118.7
Rural	15.9	15.9	15.9
Washington Coastal Subbasin	122.1	145.7	169.8
Aberdeen Service Area	39.0	45.9	52.5
Municipal	39.0	45.9	52.5
Rural	---	---	---
Chehalis-Centralia Service Area	18.8	21.8	25.1
Municipal	18.8	21.8	25.1
Rural	---	---	---
Other	64.3	78.0	92.2
Municipal	34.3	48.0	62.2
Rural	30.0	30.0	30.0
Subtotal	122.1	145.7	169.8
Municipal	92.1	115.7	139.8
Rural	30.0	30.0	30.0
Total Subregion	488.5	600.4	735.9
Municipal	351.7	475.3	624.1
Rural	136.8	125.1	111.8

The estimated population of 426,000 in 1965 is projected to increase to 735,900 by 2020. This represents an increase of only 73 percent, compared with a regional increase of 121 percent. The projected population by subbasin and service area for the years 1980, 2000, and 2020 is shown in table 104. By 2020, 85 percent of the subregion's population will be served by municipal water distribution systems, and over one-half of the population will be located in the five major service areas.

Future economic growth will continue to be based on the abundant forest resources, with the pulp and paper products industry the major water user between now and 2020. However, the primary metals industry is expected to experience the fastest growth rate in the subregion.

Production of the major water-using industries is projected to increase more than 48 percent between now and 2020 in terms of value added.

Municipal

Basis for Water Supply Projections

The projected population to be served by municipal water systems is shown in table 104. By 2020, the entire population of the major service areas is expected to be served by central systems.

Projected municipal water needs are based on population estimates and on per capita water needs presented in the "Future Needs" section of the Regional Summary. Subregion 10 is in Climatic Designation 3, as defined in the Regional Summary. The average per capita requirement is expected to be 185 gpcd by 1980, 205 gpcd by 2000, and 220 gpcd by 2020.

Projections of Water Supply Requirements

The anticipated municipal water requirements by subbasin and service area for the years 1970, 1980, 2000, and 2020 are presented in table 105. Present water use is expected to increase to 140.5 mgd by 2020. At that time, municipal requirements will account for approximately 20 percent of the total subregional needs.

Problems and Solutions

Many of the small coastal streams, springs, and wells that are sources of municipal supplies are inadequate. Factors involved are heavy requirements during low streamflow summer months, scarcity of feasible reservoir sites to store excess winter and spring runoff of streams involved, low ground-water yield, limited flow from springs, and water quality. Basin-wide, adequate quantities of water are available; however, several systems do not hold adequate water rights.

Quality problems consist mainly of dark color, offensive taste, and some odor caused by decomposition of leaves and other organic material in the late fall and high turbidities during the high-flow winter months.

Table 105 - Projected Municipal Water Use, Subregion 10

	1970	1980	2000	2020
	MGD			
Rogue Subbasin				
Medford Service Area	9.4	12.4	24.3	41.5
Other	3.7	5.5	6.6	7.5
	13.1	17.9	30.9	49.0
Umpqua Subbasin				
Coos Bay Service Area	4.7	6.6	11.8	20.8
Other	8.6	10.0	13.0	13.2
	13.3	16.6	24.8	34.0
Other Oregon Coastal Areas Subbasin				
Astoria Service Area	3.1	4.2	6.3	9.6
Other	8.0	9.3	12.9	16.6
	11.1	13.5	19.2	26.2
Washington Coastal Subbasin				
Aberdeen Service Area	5.9	7.4	9.6	12.1
Chehalis-Centralia Service Area	2.9	3.6	4.6	5.8
Other	4.9	6.2	9.6	13.4
	13.7	17.2	23.8	31.3
Total	51.2	65.2	98.7	140.5

Umpqua Subbasin Natural streamflow in the South Umpqua will be available for appropriation to Winston-Dillard and Roberts Creek Water Districts except during the months of July, August, and September. As a result, all future supplemental municipal and industrial water requirements in July through September must be developed from other sources of supply, or adequate water rights must be obtained. (14)

Rogue Subbasin Medford has a reasonably adequate, assured source of additional water supply. Grants Pass, Gold Hill, and Rogue River, however, are using available sources and water rights to almost the maximum degree and apparently lack sources which could be developed at reasonable cost. An additional supply could be provided by storage in multi-purpose reservoirs. (3)

Other Oregon Coastal Areas Subbasin No problems are anticipated in the foreseeable future.

Washington Coastal Subbasin Water needs in the Chehalis-Centralia Service Area are expected to exceed the present supply long before the end of the projection period. Several sources are available, the most readily obtainable being the Chehalis River. A water treatment plant would have to be constructed, and a water right would have to be secured. An alternative solution would be to obtain water from the multi-purpose reservoirs planned in the area.

Industrial

Basis for Water Supply Projections

Projections of industrial water use are the product of the growth index which was derived from data presented in Appendix VI and the present water use. The growth indices for the major water-use categories in Subregion 10 are shown in table 106 for the years 1980, 2000, and 2020.

Table 106 - Industrial Growth Indices, Subregion 10

	1980	2000	2020
		(Base Year 1963 = 1.00)	
Food products	1.63	2.25	3.12
Pulp and paper	1.90	2.49	2.64
Lumber and wood products	0.82	0.77	0.73
Primary metals	2.73	4.08	5.06
Chemicals	1.53	2.31	3.23

Projections of Water Supply Requirements

Projected water needs by major industrial categories are presented in table 107 for the years 1970, 1980, 2000, and 2020. Industrial requirements by 2020 will be about 504.5 mgd, or three-fourths of the total water needs in the subregion.

Table 107 - Projected Industrial Water Use, Subregion 10

	1970	1980	2000	2020
	MGD			
Pulp and paper	202.8	273.3	363.0	387.2
Lumber and wood products	38.3	51.6	48.4	45.9
Chemical products	12.6	17.0	25.6	35.9
Food products	7.8	10.6	14.6	20.3
Primary metals	6.1	8.2	12.2	15.2
Total	267.6	360.7	463.8	504.5

The pulp and paper industry will be the largest water user in the subregion, using about 387 mgd by 2020. The requirement for the lumber and wood products industry is expected to decrease slightly, but that industry will remain the second largest water user at the end of the projection period.

It is assumed that most industrial growth will occur in the general area of existing operations.

Problems and Solutions

Industries are generally located where sufficient water supplies are available, and many industries obtain all or part of their industrial supplies from municipal systems. The securing of water rights is eliminated when water is purchased from a municipality.

Rural-Domestic

Basis for Water Supply Projections

The population which will rely on individual water systems is shown in table 104. The projections show that only about 15 percent of the population will be served by individual systems by 2020.

Based on assumptions presented in the "Future Needs" section of the Regional Summary, the expected per capita water consumption for the rural population will be 60 percent of that used in nearby communities in 1980, 70 percent of the municipal use in 2000, and 80 percent in 2020. The per capita use is projected to be 110 gallons per day in 1980, 145 in 2000, and 175 in 2020.

The livestock water component of the rural-domestic requirement was derived by applying present per animal water-use factors to the projected subregional large animal population presented in Appendix VI. Water use per animal is expected to remain constant during the projection period.

Projections of Water Supply Requirements

The anticipated rural-domestic water requirements are presented in table 108 for the years 1970, 1980, 2000, and 2020. The rural-domestic need is expected to increase to about 26.1

Table 108 - Projected Rural-Domestic Water Use, Subregion 10

	1970	1980	2000	2020
	MGD			
Rogue Subbasin				
Domestic	4.1	4.8	5.0	4.3
Livestock	1.0	1.2	1.6	2.0
	5.1	6.0	6.6	6.3
Umpqua Subbasin				
Domestic	4.6	5.3	6.4	7.3
Livestock	1.1	1.3	1.7	2.2
	5.7	6.6	8.1	9.5
Other Oregon Coastal Areas Subbasin				
Domestic	1.3	1.8	2.3	2.8
Livestock	0.5	0.7	1.0	1.3
	1.8	2.5	3.3	4.1
Washington Coastal Subbasin				
Domestic	2.9	3.3	4.3	5.3
Livestock	0.4	0.5	0.7	0.9
	3.3	3.8	5.0	6.2
Total				
Domestic	12.9	15.2	18.0	19.7
Livestock	3.0	3.7	5.0	6.4
	15.9	18.9	23.0	26.1

mgd by 2020, of which 19.7 mgd will be required for domestic purposes and 6.4 mgd for livestock watering.

Problems and Solutions

The primary sources of water are springs and shallow wells, most of which utilize surface drainage. Water shortages often occur during the summer months, and many supplies have both mineral and bacterial problems. In many cases the contamination is due to improper construction which does not protect the water supply from surface drainage. Increasing water demands, heavier use of septic tanks, and larger cattle concentrations in feedlots also seem to affect the quality of individual supplies.

Consideration should be given to utilizing surface-water supplies to satisfy future needs, particularly where the ground water is not safe for use. During the summer months, both surface- and ground-water supplies are exhausted along the Tillamook River. Storage on the major streams may be necessary to provide water during this period.

Normally, most of the problems will have to be evaluated and corrected on an individual basis.

There is generally an adequate water supply for livestock use.

LOCATION MAP

SUBREGION 11

SUBREGION 11

PUGET SOUND

INTRODUCTION

Subregion 11 covers an area of 13,355 square miles entirely in the State of Washington. The area is bounded on the north by Canada, on the east by the Cascade Range, on the west by the Olympic Mountains, and on the south by a range of low hills. The central physiographic feature is a broad, north-trending structural trough flanked by mountains. The prominent cones of the Cascade Range are Mt. Baker, Mt. Rainier, and Glacier Peak.

The climate is typified by cool, dry summers and mild, wet winters. Mean annual temperatures average about 50°F., and extreme annual temperatures range from -20°F. to 106°F. Predominating air circulation brings moisture-laden air from the Pacific Ocean into the area. Resulting annual average precipitation ranges from less than 20 inches in the western sector of the Sound in the "rain shadow" of the Olympics to over 100 inches in the Olympic Mountains and Cascade Range. Three-fourths of the annual precipitation falls in the six months from October through March. Light rains account for most of the precipitation at the lower elevations, whereas heavy winter snows are the predominant form at the higher elevations in the Cascade Range and Olympic Mountains.

The principal rivers draining the east slope of the Olympic Mountains are the Elwha and the Skokomish. One stream, the Dungeness River, discharges only about one-third as much water as adjacent streams because it lies in the rain shadow of the Olympic Mountains. Numerous rivers, some of which originate in the glaciers of the higher Cascade peaks, drain the west slope of the Cascade Range. The glaciers tend to regulate streamflow, both seasonally and annually.

In the past several decades, the economy has changed from dependence on natural resources to a more diversified commercial and industrial base. However, forest industries, agriculture, and commercial fisheries still represent a significant economic force. Industries such as aerospace, aircraft, food processing, pulp and paper, and petroleum refineries are becoming increasingly important. The port facilities in this subregion are among the best on the West Coast. The numerous islands in the area also provide an outstanding recreation source.

This is the most heavily populated subregion in the region, with 1.9 million persons--about 36 percent of the region's total population. They are concentrated on the rivers and along the eastern shores of Puget Sound. The six major service areas account for about 68 percent of the population.

Subregion 11 (figure 12) is divided into the North, Central, and West Subbasins. The major service areas are the Bellingham, Everett, Seattle, Tacoma, Olympia, and Bremerton areas, which contain approximately two-thirds of the subregion's total population. Most of the data presented for this subregion were derived from information contained in reference 10.

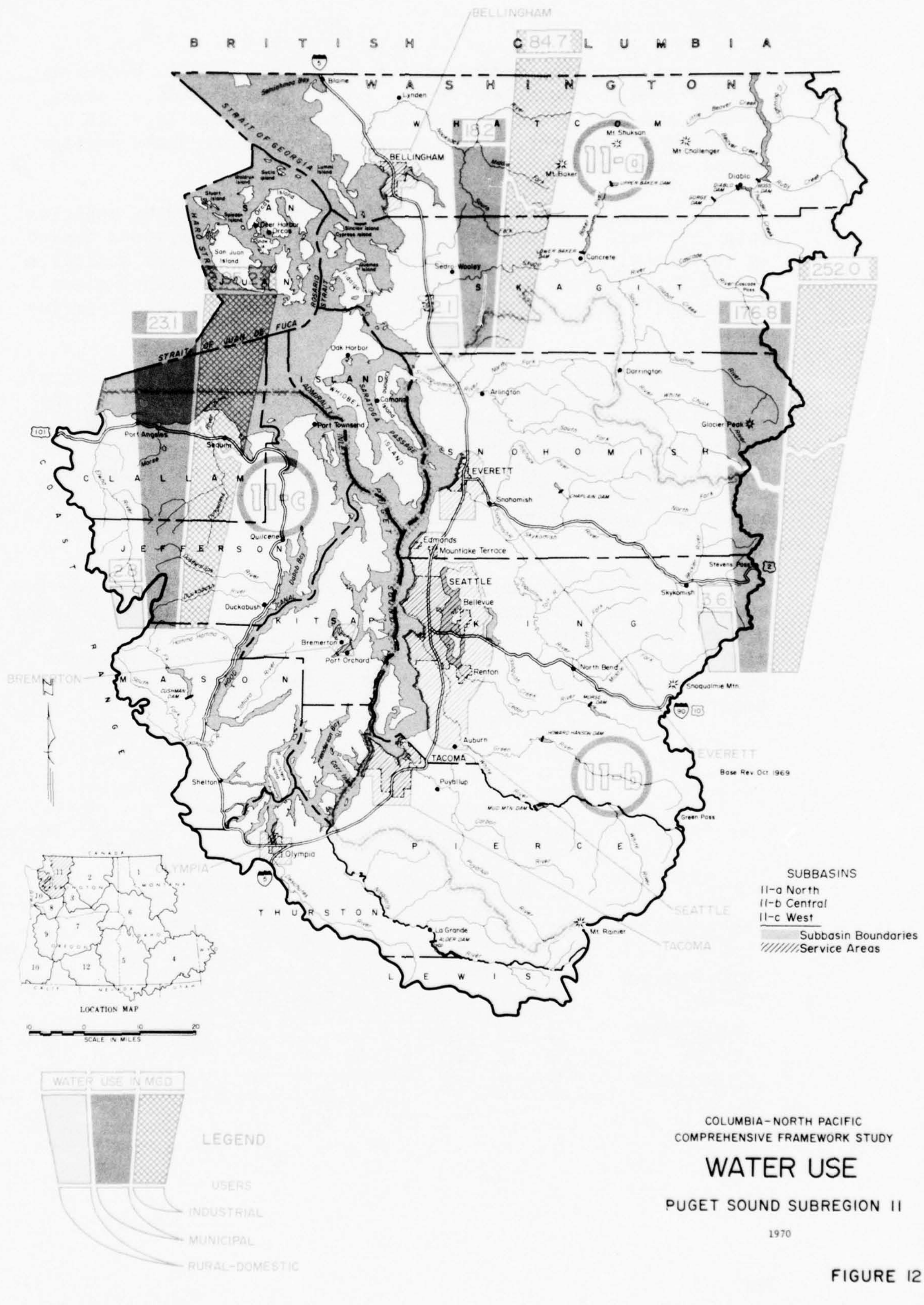
PRESENT STATUS

Table 109 is a summary of present average municipal, major industrial, and rural-domestic water use in the subregion. At present, the water requirement averages about 658 mgd, including a municipal demand of 218 mgd, an industrial demand of 432 mgd,

Table 109 - Present Municipal, Major Industrial, and Rural-Domestic Water Supply Needs, Subregion 11

	Municipal	Industrial	Rural Domestic	Total	% Total Subregion
	MGD				
North Subbasin					
Bellingham Service Area	8.9	48.1	-	57.0	8.7
Other	9.3	36.6	2.1	48.0	7.3
	18.2	84.7	2.1	105.0	16.0
Central Subbasin					
Everett Serv. Area	20.1	104.4	-	124.5	18.9
Seattle Serv. Area	91.9	19.4	-	111.3	16.9
Tacoma Serv. Area	22.4	45.7	-	68.1	10.3
Other	42.4	82.5	3.6	128.5	19.5
	176.8	252.0	3.6	432.4	65.6
West Subbasin					
Olympia Serv. Area	2.8	0.5	-	3.3	0.5
Bremerton Serv. Area	6.5	2.9	-	9.4	1.4
Other	13.8	91.8	2.8	108.4	16.5
	23.1	95.2	2.8	121.1	18.4
Total	218.1	431.9	8.5	658.5	100.0

Source: (10)



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

WATER USE

PUGET SOUND SUBREGION 11

1970

FIGURE 12

and a rural-domestic demand of 8.5 mgd. This need is generally concentrated in the major service areas. The Seattle, Everett, Tacoma, and Bellingham Service Areas require about 16.9, 18.9, 10.3, and 8.7 percent, respectively, of the subregion's average annual water demand.

Nearly 92 percent of the population is served by municipal water systems. Approximately 61.1 percent of the systems depend on surface-water sources, 24.6 percent on ground-water sources, and 14.3 percent on mixed supplies. Protected watershed areas are commonly utilized as sources of supply for the major service areas.

The principal industrial water use is for the production of pulp and paper, which requires 299 mgd, or 71 percent of the total industrial requirement. Other significant water users are the primary metals, lumber and wood products, food products, chemical products, and manufacturing industries, which require 56.8, 19.7, 18.0, 14.7, and 10.8 mgd, respectively. Most major industrial water users withdraw their supplies from municipal systems.

Table 110 summarizes monthly variations in water needs for each of the service areas. Generally, the maximum municipal need occurs in the month of August. June, July, and September are also high-use months. With the exception of the food products industry, little seasonal variation in industrial water use occurs.

Table 110 - Monthly Variation in Water Needs, Subregion 11

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
						Percent						
Bellingham Service Area												
Industrial	100	96	94	110	100	105	96	100	105	115	105	95
Municipal	100	105	100	93	93	110	115	180	105	93	94	85
Everett Service Area												
Industrial	100	103	98	98	100	103	96	104	94	100	100	93
Municipal	94	97	96	100	97	98	101	110	105	103	101	100
Seattle Service Area												
Industrial	86	85	84	86	87	100	110	107	107	117	112	95
Municipal	89	84	79	87	87	100	134	135	120	117	87	85
Tacoma Service Area												
Industrial	98	94	97	97	100	105	94	120	105	110	106	92
Municipal	85	73	83	82	100	130	162	138	94	82	75	83
Port Angeles System	97	93	90	89	97	140	160	140	100	90	75	115

Water Quality

Surface Water

The surface waters in the headwater areas of Puget Sound are generally quite acceptable for municipal and industrial water use. Many of the streams have a quality of water which requires only disinfection if diverted from a controlled-access watershed. A few streams, because of turbidity from glacial sources, a high bacterial level from waste sources, or high iron concentrations, require further treatment to make them acceptable for municipal use.

The dissolved solids concentration in most streams is usually less than 75 mg/l and rarely as high as 100 mg/l. The major dissolved ions in the water are calcium bicarbonate and silica. Industrial water users who require very low silica content would have to treat most water in the subregion. Hardness of water averages 40 mg/l or less, and the maximum is generally less than 60 mg/l. The quality of water shown in table 111 for selected communities is typical of the major surface-water supplies.

Turbidity in subregional streams is variable, with sediment from glaciers being the primary cause of most persistent high turbidity levels. The North and Middle Forks of the Nooksack River rise from glacial sources. The flow of these two streams, combined with the non-glacial-fed South Fork of the Nooksack River at Deming, has had turbidity measurements as high as 330 units, with the mean around 80 units. The Suiattle and White Chuck Rivers of the Skagit River system, and the White and Carbon Rivers of the Puyallup River system are other notable examples of rivers emanating from glaciers and often carrying high levels of turbidity. Most other rivers are very clear, with occasional brief turbid periods following intense rainstorms.

Temperatures are low in most streams, with Olympic Peninsula rivers generally cooler than those draining west to the Sound. The temperatures of most major rivers in reaches above the lowlands rarely exceed 20°C (68°F.).

Bacterial quality in the headwater areas is excellent, as indicated by low coliform counts. This is especially true in the municipal watersheds where use is limited, although studies have shown little difference in water quality between heavily used watersheds and those where access is restricted. In the lower stream reaches where agricultural and municipal wastes are found, bacterial counts increase significantly. In the upper stream reaches, coliform counts are usually less than 100 MPN per 100 ml. In the lower reaches, median levels around 1,000 MPN per 100 ml

Table 111 - Summary of Water Quality Data for Surface Water - Subregion 11

	D.O. (mg/l)	T (°C)	Coliform MPN/ 100ml	pH	Color (PT-CO) Units	Hard. (mg/l)	Turb. (JTU)	TDS (mg/l)	Ortho PO_4 (mg/l)	NO_3-N (mg/l)
Whatcom Lake near Bellingham, Wn.										
Mean	10.7	12.3	184	6.9	--	19	--	32	0.01	0.6
Min.	8.6	3.5	0	6.6	0	18	0	28	0.00	0.1
Max.	13.0	21.4	930	7.1	10	22	15	52	0.03	1.1
No. of samples	27	27	27	24	24	25	12	25	12	25
Stillaguamish River near Silvana, Wn.										
Mean	11.1	9.9	204	7.1	--	22	--	37	0.02	0.6
Min.	4.8	1.8	0	5.9	0	11	0	17	0.00	0.0
Max.	14.3	22.8	1,500	7.6	45	39	400	58	0.10	2.0
No. of samples	87	87	87	83	83	83	44	83	72	83
Nooksack River at Ferndale, Wn.										
Mean	11.1	9.1	2,488	7.2	--	36	--	56	0.02	0.8
Min.	5.1	2.0	36	6.8	0	22	5	32	0.00	0.1
Max.	13.6	17.5	24,000	7.7	25	53	700	77	0.05	2.5
No. of samples	60	60	60	57	57	57	46	57	46	57
Skagit River at Marblemount, Wn.										
Mean	11.7	8.3	40	7.3	--	22	--	32	0.01	0.3
Min.	9.7	3.8	0	6.8	0	12	0	18	0.00	0.0
Max.	13.3	15.2	230	8.0	5	30	5	44	0.08	1.1
No. of samples	37	37	37	36	36	36	15	36	33	36
Snohomish River at Snohomish, Wn.										
Mean	11.0	10.0	2,050	6.9	--	15	--	30	0.02	0.7
Min.	8.3	4.0	23	6.4	5	8	0	14	0.00	0.0
Max.	14.0	19.0	24,000	7.4	20	22	160	40	0.12	2.6
No. of samples	62	62	62	59	58	59	43	59	--	--
Green River near Auburn, Wn.										
Mean	11.1	10.1	1,225	7.2	--	24	--	51	0.03	0.7
Min.	8.3	3.5	0	6.2	0	14	0	30	0.00	0.0
Max.	14.1	24.2	24,000	7.9	15	39	40	71	0.13	1.9
No. of samples	88	87	86	84	83	84	45	84	73	84
Goldsborough Creek near Shelton, Wn.										
Mean	10.5	10.4	878	7.4	--	71	--	99	0.05	0.6
Min.	8.3	4.5	36	6.8	0	20	0	40	0.00	0.0
Max.	12.5	17.0	4,300	8.2	20	136	20	178	0.13	1.9
No. of samples	23	23	23	24	12	24	12		12	24
Cedar River at Renton, Wn.										
Mean	10.8	10.6	420	7.2	--	24	--	44	0.03	0.5
Min.	7.6	4.1	0	6.9	0	16	0	34	0.00	0.0
Max.	12.5	22.8	4,600	7.9	10	46	25	77	0.28	1.9
No. of samples	50	51	50	46	46	46	16	46	43	46
Big Quilcene River near Quilcene, Wn.										
Mean	11.4	8.9	42	7.4	--	40	--	62	0.03	0.3
Min.	9.8	3.6	0	6.8	0	30	0	43	0.00	0.0
Max.	13.5	15.6	430	7.8	15	57	5	94	0.32	1.0
No. of samples	27	28	29	29	28	29	10	29	27	29
Skagit River near Mt. Vernon, Wn.										
Mean	11.2	9.3	1,849	7.1	--	22	--	35	0.02	0.4
Min.	9.3	4.0	0	6.3	0	13	0	0	0.00	0.0
Max.	13.7	17.8	24,000	8.1	20	32	350	52	0.07	1.5
No. of samples	88	87	87	84	84	86	44	86	73	86

Table 111 (Continued)

	D.O. (mg/l)	T (°C)	Coliform MPN/ 100ml	pH	Color (PT-CO Units)	Hard. (mg/l)	Turb. (JTU)	TDS (mg/l)	Ortho PO_4 (mg/l)	NO_3-N (mg/l)
Sultan River at Sultan, Wn.										
Mean	11.2	9.9	88	7.0	--	15	--	27	0.01	0.4
Min.	8.5	3.5	0	3.9	0	8	0	15	0.00	0.1
Max.	13.7	21.3	930	8.1	20	31	75	56	0.07	0.8
No. of samples	35	34	35	35	35	35	16	35	--	--
Snoqualmie River at Snoqualmie, Wn.										
Mean	11.1	9.1	1,439	6.9	--	12	--	25	0.02	0.5
Min.	9.0	3.2	0	6.2	5	6	0	14	0.00	0.0
Max.	13.2	17.5	4,600	7.4	40	18	40	33	0.12	1.8
No. of samples	36	36	35	34	30	34	14	34	31	34
Tolt River near Carnation, Wn.										
Mean	11.1	10.6	84	7.1	--	17	--	33	0.01	0.4
Min.	8.7	3.7	0	6.6	5	9	0	21	0.00	0.1
Max.	14.7	23.2	430	7.5	30	27	50	47	0.03	1.0
No. of samples	35	34	34	34	34	34	15	34	31	34
Puyallup River at Puyallup, Wn.										
Mean	10.8	9.3	5,521	7.0	--	24	--	53	0.05	0.7
Min.	9.3	2.9	0	6.3	0	16	0	36	0.01	0.1
Max.	12.4	18.3	24,000	7.5	20	40	400	74	0.13	2.0
No. of samples	43	42	43	42	42	42	16	42	28	42
Deschutes River at Tumwater, Wn.										
Mean	10.7	10.1	646	7.2	--	34	--	74	0.07	1.1
Min.	8.7	4.0	0	6.6	5	20	0	54	0.00	0.6
Max.	11.7	20.1	2,400	7.8	20	46	30	89	0.12	1.6
No. of samples	16	16	16	15	15	15	10	15	12	15

are recorded for the Nooksack, Skagit, Snohomish, and Sammamish Rivers; and 5,000 MPN per 100 ml are recorded for the Duwamish and Puyallup Rivers.

Ground Water

The mineral quality of ground-water supplies for selected communities is listed in table 112. In general, ground water is of satisfactory quality for domestic use. One significant chemical quality problem is the high iron content found in scattered locations throughout the subregion. These high iron levels are above recommended PHS standards and, unless the iron is removed by treatment, can cause discoloration of laundry and plumbing fixtures, as well as possible adverse taste effects.

The water generally has dissolved solids of less than 200 mg/l. Silica may be 20 to 60 mg/l, and the water is soft to moderately hard. Temperatures generally range from about 48°F. to 55°F.

Table 112 - Mineral Water Quality of Ground-Water Supplies, Subregion 11

	SiO_2	Fe	Ca	Mg	Na	HCO_3	SO_4	Cl	NO_3-N	Total Solids	Hard. $CaCO_3$	F	pH
	mg/l												
Ferndale, Wn. 12/17/59	21	0.06	45	23	132	289	24.0	162	0.0	563	206	0.2	8.4
Blaine, Wn. 3/26/58	26	0.13	14	6.8	9.9	96	8.8	2.0	0.0	119	63	0.1	8.0
Skagit Co., Wn. PUD #1 4/18/52	43	0.02	14	8.3	8.0	75	10	7.3	8.2	139	69	0.1	7.0
Edmonds, Wn. 12/18/59	36	0.00	9.5	9.4	5.9	70	10	5.0	3.3	116	62	0.1	7.6
Marysville, Wn. 12/18/59	25	0.81	18	7.5	6.1	104	2.8	2.5	0.2	116	76	0.2	7.8
Arlington, Wn. 4/27/61	8.5	0.08	9	3.5	2.2	41	8.0	1.5	0.7	54	37	0.0	7.2
Stanwood, Wn. (Well 4) 10/5/60	33	0.13	22	13	16	158	11	6.0	0.6	187	106	0.2	8.2
Renton, Wn. 6/23/60	14	0.00	12	3.5	4.0	49	10	2.2	0.8	71	44	0.1	6.9
Redmond, Wn. 3/24/59	23	0.06	10	4.7	4.9	50	5.4	3.8	5.6	84	44	0.1	7.3
Lakewood, Wn. W.D. 3/22/60	41	0.46	9.0	5.2	6.1	67	2.1	2.2	0.5	101	44	0.1	7.5
Tacoma, Wn. (Well-IIA) 10/25/60	28	0.04	16	11	7.1	78	17	9.5	9.2	138	86	0.1	7.1
Gig Harbor, Wn. (Well 1) 3/2/61	34	0.22	12	6.9	5.5	83	0.4	2.2	0.3	105	58	0.1	7.8
Yelm, Wn. 11/12/59	23	0.25	9.0	2.9	4.6	38	4.4	3.8	5.0	73	34	0.0	6.7
Port Orchard, Wn. (Well 6) 3/3/61	35	0.04	18	3.6	5.5	81	1.2	1.2	0.1	108	1	0.0	8.4
Bremerton, Wn. (Well 5) 12/16/59	31	0.01	15	2.6	6.9	69	3.4	1.5	0.0	99	48	0.3	8.3
Coupeville, Wn. 5/19/60	36	0.09	82	61	51	490	47	82	0.1	612	454	0.2	7.7

Treatment

A summary of municipal water treatment practices in Subregion 11 is presented in table 113. Mineral removal and specialized treatment are not listed. Communities utilizing mixed or surface supplies generally provide at least disinfection before distribution. Complete treatment (chemical coagulation, sedimentation, rapid sand filters, and chlorination) is not presently required by the State Health Department, if most surface sources are well protected from human waste sources. However, several supplies must provide filtration facilities for turbidity removal and are included in the complete treatment category. Treatment of ground water is not extensive. Only one-third of the communities relying upon underground sources operate disinfection facilities.

Table 113 - Summary of Municipal Water Sources and Treatment Practices, Subregion 11 (10)

Source	Number of Municipal Facilities	Population Served Thousands	Percent of Total Population
Surface			
No treatment	5	3.5	0.2
Disinfection	14	1,015.3	57.9
Complete	4	53.2	3.0
	23	1,072.0	61.1
Ground			
No treatment	82	188.6	10.7
Disinfection	42	243.6	13.9
Complete	-	-	-
	124	432.2	24.6
Mixed			
No treatment	5	9.9	0.6
Disinfection	11	235.0	13.4
Complete	3	5.5	0.3
	19	250.4	14.3
Total	166	1,754.6	100.0

North Subbasin

Municipal

Approximately 118,200 persons, or 76 percent of this subbasin's population, are served by municipal water systems. The municipal population has an average annual water requirement of 18.2 mgd. Most of this need is centered in the Bellingham Service Area and the Mt. Vernon-Anacortes area.

The Bellingham Service Area has an average municipal water requirement of about 8.9 mgd. The City of Bellingham obtains its water supply from Lake Whatcom and diversion of the Middle Fork Nooksack River to the lake. The present diversion capacity from the river nearly equals the average daily system requirement (including industrial needs). Septic tank drainage from homes located along the northwestern portion of the lake contributes to bacterial contamination. Since this presents a potential health hazard, a filtration plant was recently constructed to further safeguard municipal water quality.

The municipal population in the Mt. Vernon-Anacortes area relies primarily on surface water for its source of supply. The City of Anacortes, which uses about 1.4 mgd, withdraws its supply from the Skagit River. Iron concentrations ranging from 0.5 to 2.5 mg/l necessitate iron removal by pH adjustment and filtration.

The Skagit County PUD No. 1 water system serves Mt. Vernon, Sedro Woolley, and Burlington. The PUD supplies a municipal population of about 23,500 persons with a requirement of 2.0 mgd. The supply is obtained principally from the Cultus Mountain watershed lying on the western extremity of the Cascade Range. Transmission line capacity from the reservoir to the PUD distribution system is 12.5 mgd. A secondary source of supply is a 4 mgd Ranney well located in north Mt. Vernon and a 1 mgd conventional well in Sedro Woolley. A 2 mgd pumping and water treatment plant in Mt. Vernon utilizes the Skagit River for peaking and standby service.

Most of the remaining municipal systems use ground water. Only the communities of Lynden and Friday Harbor withdraw supplies entirely from surface sources.

Industrial

The industrial water requirement in the North Subbasin is about 84.7 mgd. The principal industrial users are the pulp and paper, chemical products, primary metals, and food products industries. These industries have water needs of about 51.9,

11.6, 8.0, and 8.9 mgd, respectively. Approximately 65 percent of the industrial requirement is centered in the Bellingham Service Area.

A pulp and board mill, served by Bellingham, is the largest industrial water user in the subbasin. The calcium-base sulfite mill has an average need of 46.0 mgd. The only other significant industrial use in the Bellingham Service Area is that of the food products industry. An annual water requirement of about 1.0 mgd is withdrawn from the Bellingham municipal system for food processing.

A significant industrial water requirement exists in the Ferndale area. An aluminum reduction plant west of Ferndale operates two potlines. The plant uses an average of 7.0 mgd from the Whatcom County PUD No. 1 system, which obtains water from the Nooksack River. A refinery, also located west of Ferndale, refines crude oil. The plant is the only major industry in the subbasin that has developed an independent water supply. The refinery withdraws an average of about 2.0 mgd from the Nooksack River.

In the Mt. Vernon-Anacortes area, a paper company and petroleum refineries, served by the Anacortes system, are the major industrial water users. The paper plant, which utilizes an ammonia-base sulfite process for production of short-fiber pulp, requires about 5.5 mgd. The petroleum refineries have a combined water requirement of about 7.0 mgd. The food products industry in Mt. Vernon and Burlington needs about 2.3 mgd. The Skagit County PUD No. 1 water system supplies this need.

Rural-Domestic

Approximately 37,797 persons, or 24 percent of the North Subbasin's population, are served by individual water systems and have an average annual water requirement of about 2.1 mgd. About 90 percent of these systems use ground water as a source of supply.

The locale of private service, primarily in the western section of the subbasin, generally overlies ground-water supplies of adequate yield and good chemical quality. However, many small cooperative water systems have been formed in areas where ground water is deep and expensive to reach on an individual basis, or where iron concentrations are sufficiently high to be objectionable. These rural systems serve much of the area surrounding Lynden and west of Ferndale.

Central Subbasin

Municipal

Approximately 1,531,300 persons, or 96 percent of the Central Subbasin's population, are served by municipal water systems. The municipal population has an average annual water requirement of 176.8 mgd. Most of this need is centered in the Everett, Seattle, and Tacoma Service Areas. Water for municipal purposes is primarily supplied from the Sultan, Green, Cedar, and Tolt Rivers.

The water supply for the City of Everett, which provides water to Monroe and to the Alderwood Water District, which, in turn, supplies the cities of Mountlake Terrace, Brier, Lynnwood, and Edmonds, is obtained from the semi-controlled Sultan River watershed. Total average municipal water use in the service area is about 20.1 mgd. Everett supplies about 90 percent of the municipal water requirement of the urban area. The remainder is supplied by separate facilities of several communities and water companies.

The Seattle Service Area has an average municipal water requirement of about 91.9 mgd. Over a million persons living in the Seattle metropolitan area and suburban cities are being served. Over one-half of the subbasin's total municipal water use occurs in this metropolis. The City of Seattle utilizes two catchment areas for its municipal supply--the Cedar River and Tolt River watersheds, which are closed to general public access. The community of Renton is the second largest water supplier in the service area. The source of supply is five wells, which serve over 38,000 people with 4.1 mgd. In the Green River Valley, the City of Auburn serves 17,100 persons with about 3.0 mgd. Nearby Kent supplies 10,460 persons with 2.5 mgd. Both spring and well-water sources are utilized by Auburn and Kent. Many of the remaining communities in the service area rely on wells and small surface sources for their water supplies.

The Tacoma Service Area has a municipal water requirement of 22.4 mgd. Tacoma's primary source is the Green River. About 90 percent of the city's water supply is obtained from the river, and the balance is pumped from wells. The Green River watershed is forested, and public access is restricted from the west but is only partially restricted from the east. As a result, some recreation use occurs in the watershed. The system of wells serves as an auxiliary supply, which is used during emergencies and when the Green River is unusable due to heavy rains causing turbidity.

The municipal water need outside of the three major service areas is about 42.4 mgd. In general, most of the communities in this portion of the subbasin use ground water, although some suppliers use surface sources. The most important concentration of municipal use is in the Puyallup River Basin. Nearly 187,000 persons in this area are served by municipal facilities. The largest municipal supplier is the Lakewood Water District, which covers an area of about 20 square miles south of Tacoma. The district withdraws about 6.8 mgd from wells to supply about 40,000 people. The Fort Lewis military complex requires about 10.2 mgd to serve an average of about 60,000 persons. Wells and springs are used as a source of supply. Four communities in the Puyallup River Basin--Puyallup, Sumner, Buckley, and Orting--and several water districts together use slightly more than 6.8 mgd.

Industrial

The industrial water requirement in the Central Subbasin is about 252.0 mgd. The principal industrial water users are the pulp and paper, chemicals, metals and oils, lumber and wood products, and food products. These industries have average water needs of about 172.4, 52.6, 8.6, and 8.7 mgd, respectively. In general, the needs are concentrated in the Everett, Seattle, and Tacoma Service Areas.

The pulp and paper plants located in Everett are the largest individual water users in the Central Subbasin. Three plants obtain water from the City of Everett under a contract agreement. Total average annual water use of the three plants is 102 mgd. A sulfate pulp mill in Everett presently obtains water from the Snohomish River. The plant, which uses 32 mgd, is the largest industrial water user in the subbasin with a private source of supply. Other industrial water use in the Everett Service Area is comparatively minor and is supplied by the municipal system.

The industrial water requirement in the Seattle Service Area is 56.7 mgd. The largest water use is that of the primary metals industry (including sand-and-gravel operations), which has an average water need of about 42.1 mgd. Two plants in Seattle are the largest individual water users. These plants require 23.0 and 8.1 mgd, respectively. Several sand-and-gravel operations in the service area account for a water use of about 7.4 mgd. In addition, a cement plant utilizes about 3.2 mgd. Manufacturing industries in the area have a water requirement of about 7.9 mgd. The aircraft industry is the most significant of these water users, with an average requirement of about 6.4 mgd. Other significant industrial water uses in the Seattle Service Area are for food products and lumber and wood products, which need 3.9 and 3.0 mgd, respectively.

The Tacoma Service Area has an industrial water requirement of 45.4 mgd. The pulp and paper, primary metals, and chemical products industries are the major water users. With few exceptions, these industries depend upon municipal systems for water supplies. A paper company, which uses an average of 30.5 mgd, has the largest water requirement in the service area. The primary metals industry has water need of 6.4 mgd. Three chemical products firms have a combined water requirement of about 5.7 mgd.

The most important industrial water uses outside of the three major service areas are by lumber and wood products plants at Snoqualmie Falls, and pulp and paper industries at Steilacoom and at Sumner. These industries require 13.0, 5.0, and 1.1 mgd, respectively.

Rural-Domestic

Approximately 63,780 persons, or 4 percent of the Central Subbasin's population, with an average annual water need of about 3.6 mgd, are served by individual water systems. An estimated 90 percent of the individual systems utilize ground-water supplies.

West Subbasin

Municipal

Approximately 167,770 persons, or 76 percent of the subbasin's population, are served by municipal water systems. This portion of the population has an annual average requirement of about 22.1 mgd. Most of the need is concentrated in the Olympia and Bremerton Service Areas and in the Port Angeles, Port Townsend, and Shelton areas.

The Olympia Service Area, which includes the communities of Olympia, Tumwater, and Lacey, has an average water requirement of about 4.3 mgd. The City of Olympia has developed McAllister Springs, located at the southern end of Nisqually Flats, as its municipal supply. The city utilizes about 2.8 mgd. The community of Tumwater relies upon ground water as its source of supply, with about 0.6 mgd being pumped from its wells for municipal purposes.

The City of Bremerton has an annual water need of about 6.5 mgd. The City of Bremerton utilizes both surface and ground water as its sources of supply. The system is the largest in the West Subbasin. In addition to seven wells, several small streams are utilized along Gorst Creek, Anderson Creek, and Casad Reservoir on the Union River. Port Orchard derives its supply

from four artesian wells. This system supplies an average water requirement of 0.4 mgd. Traces of hydrogen sulfide have been found in a portion of the water supply.

Port Angeles also has a significant water requirement of about 3.8 mgd. Port Angeles and Port Townsend have developed surface-water sources for their supplies, and Shelton relies upon spring and well-water.

Industrial

The industrial water requirement in the West Subbasin is approximately 95.2 mgd. The pulp and paper industry is the principal water user, requiring 88 mgd. Minor quantities of water are needed for the lumber and wood products and the food products industries.

Industrial water use centers in the Port Angeles area in three pulp mills and totals nearly 60 mgd. The largest industrial water user produces about 467 tons of pulp per day by a calcium-base sulfite process, and uses an average of 36.2 mgd. These three pulp and paper mills are supplied with raw water from the Elwha River. The Fibreboard mill withdraws water from the city when its primary source from the industrial line is too turbid for making paper.

A pulp and paper mill at Port Townsend withdraws about 17.0 mgd from the Big and Little Quilcene Rivers.

Water use by the naval shipyards at Bremerton amounts to 2.9 mgd. The source of supply is the Bremerton municipal system.

Other significant industrial water users are a timber company in Shelton and a brewing company in Tumwater, which use 2.3 and 2.2 mgd, respectively.

Rural-Domestic

About 51,560 persons, or 24 percent of the West Subbasin's population, are served by municipal water systems, and have an average water requirement of about 2.8 mgd. An estimated 90 percent of the individual systems are served by underground sources. Most of the surface-water supplies utilized are considered unsatisfactory.

FUTURE NEEDS AND MEANS TO SATISFY NEEDS

The principal factors influencing future water needs in Subregion 11 are population expansion and industrial growth. By 2020, the population is projected to reach 6,942,000 people--more than a three-fold increase over the present population of nearly 2 million. The projected population by subbasin and service area for the years 1980, 2000, and 2020 is shown in table 114. About 65 percent of the projected 2020 population will be centered in the Everett, Seattle, and Tacoma Service Areas.

Production growth of the major water-using industries is projected to substantially increase by 2020 in terms of dollar value. It is anticipated that pulp and paper, food and kindred products, primary metals, and chemicals and petroleum will continue to be the major industries in the subregion. The aerospace or transportation industry, although not an extremely heavy water-using industry, will continue to exert its influence on the subregion's economy. Production growth for the major water-using industries is expected to realize an 82 percent increase from 1965 to 1980 in terms of value added. Food and kindred products, paper and allied products, and primary metals are projected to lead this growth. Relatively large increases are also projected for the chemical and petroleum industries.

The North Subbasin is projected to show the largest increase in economic activity through 1980. Aluminum, petroleum refining, and university and research facilities will lead the way.

In the central part of the subregion the big growth industries--in the Cedar-Green, Snohomish, and Puyallup Basins--will be transportation equipment, construction, machinery trade, finance, insurance, real estate, and services.

Major growth strength in the western part of the subregion will be drawn from the pulp and paper products component of the forest products industry; but there will be a decline in the wood products industry.

Municipal

Basis for Water Supply Projections

The projected population to be served by municipal water systems, as shown in table 114, indicates that by the year 2020, approximately 97 percent of the population will obtain water from

central distribution systems. It is expected that the entire population of the major service areas will be served by these central distribution systems by that time.

Projections of future water use are derived from information presented in Reference 10.

Projections of Water Supply Requirements

The projected municipal requirements by subbasin and service area for the years 1970, 1980, 2000, and 2020 are presented in table 115. The present water use is forecast to increase to 1,231 mgd by 2020. By 2020, this municipal water use will account for approximately 39 percent of the total subregional needs. Future needs are expected to be concentrated in the major service areas. The Seattle Service Area is expected to account for 39 percent of the municipal needs by the end of the projection period.

Table 114 - Projected Population, Subregion 11

	1980	2000	2020
	Thousands		
North Subbasin	185.50	249.90	341.50
Bellingham Service Area	55.00	75.00	100.40
Municipal	55.00	75.00	100.40
Rural	-	-	-
Other	130.50	174.90	241.10
Municipal	92.00 1/	132.03 1/	192.90 1/
Rural	38.50	42.87	48.20
Subtotal	185.50	249.90	341.50
Municipal	147.00	207.03	293.30
Rural	38.50	42.87	48.20
Central Subbasin	2,261.70	3,631.00	5,832.10
Everett Service Area	79.20	250.00	450.00
Municipal	79.20	250.00	450.00
Rural	-	-	-
Seattle Service Area	1,271.20	2,079.90	3,419.70
Municipal	1,271.20	2,079.90	3,419.70
Rural	-	-	-
Tacoma Service Area	250.00	423.00	730.00
Municipal	250.00	423.00	730.00
Rural	-	-	-
Other	661.30	878.10	1,232.40
Municipal	578.90	780.00	1,125.50
Rural	82.40	98.10	106.90
Subtotal	2,261.70	3,631.00	5,832.10
Municipal	2,179.30	3,532.90	5,725.20
Rural	82.40	98.10	106.90

	1980	2000	2020
	Thousands		
West Subbasin	312.60	503.10	777.20
Olympia Service Area	51.10	100.70	157.40
Municipal	51.10	100.70	157.40
Rural	-	-	-
Bremerton Service Area	70.00	116.70	169.50
Municipal	70.00	116.70	169.50
Rural	-	-	-
Other	191.50	285.70	450.30
Municipal	132.30	220.00	363.60
Rural	59.20	65.70	86.70
Subtotal	312.60	503.10	777.20
Municipal	253.40	437.40	690.50
Rural	59.20	65.70	86.70
Total Subregion	2,759.80	4,384.00	6,950.80
Municipal	2,579.70	4,177.33	6,709.00
Rural	180.10	206.67	241.80

Note: The above projections were taken from the Type 2 study. The following OBE projections are shown for comparison purposes:

	1980	2000	2020
Puget Sound Subregion	2,449.7	3,345.3	4,448.1
Municipal	2,315.0	3,228.6	4,350.1
Rural	134.7	116.7	98.0

Source: (10)
1/ Does not include summer population on San Juan Islands.

Table 115 - Projected Municipal Water Use, Subregion 11

Area	1970	1980	2000	2020
	MGD			
North Subbasin	21.49	28.10	43.52	67.72
Bellingham Service Area	9.43	10.50	15.80	23.10
Other	12.06 1/	17.60 1/	27.72 1/	44.62 1/
Central Subbasin	249.40	394.60	601.90	1,005.20
Everett Service Area	24.80	34.20	52.50	104.00
Seattle Service Area	135.27	222.00	297.00	475.00
Tacoma Service Area	30.78	47.60	88.90	168.00
Other	58.55	90.80	163.50	258.20
West Subbasin	31.84	49.33	90.90	158.55
Olympia Service Area	5.43	10.70	21.60	40.00
Bremerton Service Area	8.77	13.30	24.40	39.00
Other	17.64	25.33	44.90	79.55
Total	302.73	472.03	736.32	1,231.47

Source (10)

1/ Does not include maximum use for projected summer population in San Juan Islands.

Problems and Solutions

There is no subregion-wide shortage of water for present and projected requirements. However, in some basins there will be shortages which will require imaginative planning of future developments for interbasin transfer, greater utilization of ground-water resources, and perhaps even desalinization.

Except for the San Juan Islands, quantity and quality, on the whole, are adequate for all requirements, contingent upon certain individual basins being able to import water from basins having adequate supplies. Projections of use for the San Juan Islands appear to be far in excess of available sources of water supply.

Communities in the Cedar-Green and Puyallup Basins are presently depending upon imported water to a great degree and will draw upon these sources to a much greater extent as their population and industry increase.

Interbasin transfers will increase in number and size as urban needs proceed upward. From an engineering standpoint, there are few insoluble problems, and the joint development of a river or ground-water basin can confer advantages much greater than could be obtained by the aggregate of a number of individual schemes.

The primary source of water up to the year 2020 will be surface water. Communities in the Cedar-Green Basin and the San Juan and Whidbey-Camano Islands must import water because their increasing needs are greater than the potential supply.

The San Juan Islands' future water supply appears to be assured only with a feasible scheme of water reclamation and reuse. Desalinization, recharge of known aquifers, and further location and testing of additional ground-water reservoirs for augmenting meager surface-water supplies offer some possibilities.

As the subregion developed, encroachment on the watersheds became an increasing problem; and many cities, recognizing the requirements of the future, took steps to gain more positive control of these areas. Seattle, Tacoma, and Bremerton improved their control by outright purchases of portions of their watersheds. Seattle purchased a major portion of the Cedar River watershed above Landsburg; Bremerton purchased portions of the Gorst watershed; and Tacoma purchased 26 miles of river access on the Green River.

Access to watersheds in the area is limited in many cases by their remote locations and lack of roads. Future access by available roads is expected to be carefully controlled. Recreational use of the watersheds is discouraged, although completely restricted in only the Bremerton and Seattle watersheds. Logging activities in these areas will continue to be closely supervised, and other activities, such as summer cattle grazing, will continue to be strictly controlled.

Industrial

Basis for Water Supply Projections

Projections of industrial water use in Subregion 11 were taken from Reference 10.

Projections of Water Supply Requirements

Projected water needs by major industrial categories are presented in table 116 for the years 1970, 1980, 2000, and 2020. By 2020, the total industrial water requirement is projected to be 1,930 mgd, or nearly 60 percent of the total needs in the subregion.

Table 116 - Projected Industrial Water Use, Subregion 11

	1970	1980	2000	2020
	MGD			
Pulp and paper	393.8	555.1	845.9	955.8
Primary metals, chemicals, oils	99.1	144.8	301.0	682.7
Transportation	9.6	16.5	61.1	150.2
Lumber and wood products	10.0	8.4	7.6	7.2
Food products	22.5	28.7	57.5	105.9
Others	8.3	12.4	12.4	28.8
Total	543.3	765.9	1,285.5	1,930.6

The pulp and paper industry will be by far the largest water user, requiring 956 mgd by 2020. The primary metals, chemicals, and oils industries will also be a large water user, with 683 mgd needed by 2020. The water requirement for the lumber and wood products industry, however, is projected to decline slightly during the projection period.

In general, the increases in water use have been projected to occur at existing locations. Although industries will undoubtedly locate in other new areas, locational shifts were not projected in the economic analyses.

Problems and Solutions

Most industries in the subregion obtain water through municipal supply systems. Some, however, provide their own water requirements by diversion from surface sources or through a well system. Self-supplied industries utilizing ground-water sources are expected to continue using these sources with little difficulty, as ground-water sources are generally more than adequate. In certain areas, ground water is limited. Those utilizing surface sources should have adequate supplies, but the possibility of

encountering shortages is somewhat greater due to the expected increase in competition among water uses, which will probably necessitate the establishment of minimum base flows.

Municipalities are expected to adequately develop new sources as the needs arise and should have no difficulty in supplying the municipal and industrial water demands on their systems.

Rural-Domestic

Basis for Water Supply Projections

The population projected to rely on individual water systems is shown in table 114. The projections indicate that only slightly over three percent of the population will be served by individual systems by 2020. Both the population projections and the total rural-domestic water use data were derived from Reference 10.

The projected livestock population in the subregion is based on data presented in Appendix VI. It has been assumed, for purposes of this study, that the water use per animal will remain constant during the projection period.

Projections of Water Supply Requirements

Anticipated rural-domestic water requirements are presented by subbasin for the years 1970, 1980, 2000, and 2020 in table 117. The rural-domestic need is forecast to increase by 2020 to about 27 mgd, of which approximately 17 mgd will be required for domestic purposes and about 10 mgd for livestock watering.

Problems and Solutions

Ground-water supplies in the subregion are generally adequate in quality and quantity to satisfy existing and projected needs of the rural-domestic population segment. In certain areas, however, localized quality problems exist. High iron concentrations are encountered primarily in the North Subbasin. In addition, in some localities near shorelines, ground water is highly mineralized because of the encroachment of seawater into the freshwater zones as a result of pumping. This condition has been encountered on Whidbey Island, where many wells have been affected by saltwater intrusion. This area, however, is expected to be served in the future from surface sources such as the Skagit

River. In time, as the population in this area grows, the development of an island-wide distribution system is expected to replace the existing individual ground sources.

Table 117 - Projected Rural-Domestic Water Use, Subregion 11

	1970	1980	2000	2020
	MGD			
North Subbasin				
Domestic	0.9	0.4	0.8	1.3
Livestock	1.4	2.3	3.1	4.1
	2.3	2.7	3.9	5.4
Central Subbasin				
Domestic	2.8	3.7	6.0	7.9
Livestock	1.5	2.1	2.8	3.7
	4.3	5.8	8.8	11.6
West Subbasin				
Domestic	2.5	3.2	4.7	8.1
Livestock	0.7	0.9	1.2	1.5
	3.2	4.1	5.9	9.6
Total				
Domestic	6.2	7.3	11.5	17.3
Livestock	3.6	5.3	7.1	9.3
	9.8	12.6	18.6	26.6

Source: (10)

LOCATION MAP

SUBREGION

12

SUBREGION 12

OREGON CLOSED BASIN

INTRODUCTION

Subregion 12 is in southeastern Oregon and contains 17,805 square miles. The area is enclosed by the Ochoco Mountains on the north, Steens Mountains on the east, the Calico and Black Ranges on the southeast, the Warner Mountains on the south, and the Fremont Mountains on the west. The streams drain into brackish landlock lakes with no drainage to the sea.

The climate is semiarid, with long and rather severe winters and short summers with many clear days. The average maximum summer temperatures are in the upper 80's and the minimums in the lower 40's. The average annual precipitation ranges from 10 to 25 inches in the higher mountains.

The primary municipal and industrial water-use centers in the subregion (figure 13) are in the Burns area, which includes Burns and Hines. About 40 percent of the population of the subregion resides in this area.

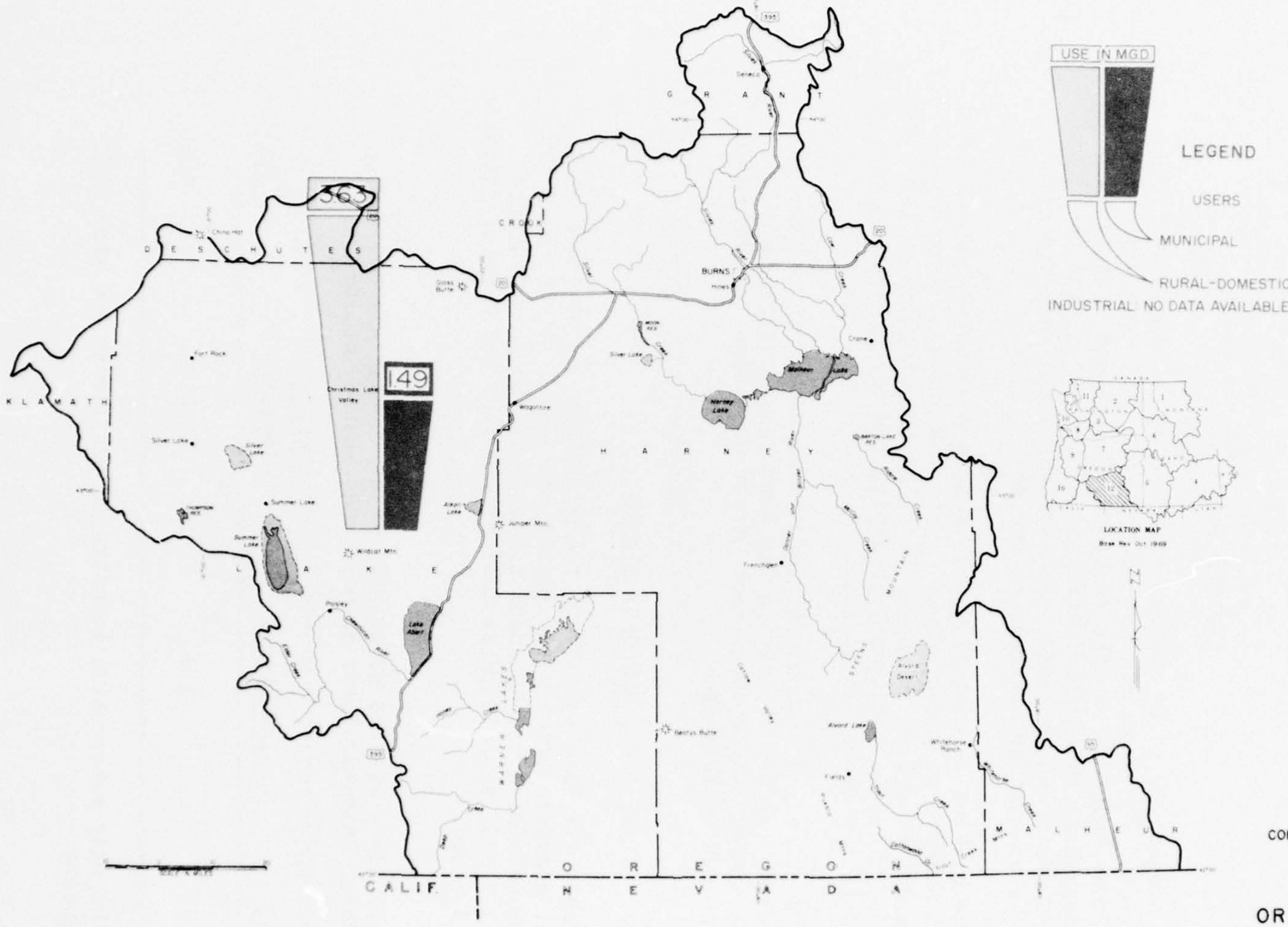
PRESENT STATUS

Table 118 is a summary of the municipal, major industrial, and rural-domestic water needs in the subregion. At present, the water requirement averages about 6.5 mgd, including a municipal need of 1.5 mgd, an industrial need of 1.4 mgd, and a rural-domestic need of 3.6 mgd.

Table 118 - Present Municipal, Major Industrial, and Rural-Domestic Water Supply Needs, Subregion 12

Municipal	Industrial	Rural-Domestic	Total
	MGD		
1.5	1.4	3.6	6.5

The only water-using industry is the lumber and wood products industry.



COLUMBIA–NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

WATER USE

OREGON CLOSED BASIN
SUBREGION 12

1970

FIGURE 13

Table 119 summarizes monthly variation in water needs. Since no data concerning the municipal monthly pattern are available, a statistical analysis of water supply distribution for similar areas in the Pacific Northwest was used to derive the figures. There is little seasonal water-use variation for the lumber and wood products industry.

Table 119 - Monthly Variation in Water Needs, Subregion 12

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
						MGD						
Municipal	67	70	71	86	90	143	186	145	121	81	72	66
Industrial												
Lumber and wood products	100	100	100	100	100	100	100	100	100	100	100	100

Water Quality

Surface Water

The surface streams of the subregion are of excellent quality for irrigation and generally require only disinfection for municipal or industrial use. However, many streams have intermittent flow, and water is not available at all times in the quantities needed.

The surface waters do not reach the sea but form interior drainages. Water quality data are limited, and no continuing data are available. Miscellaneous samples collected at various times indicate that the surface streams are similar in chemical composition to most of the streams of mountainous origin in the State of Oregon.

The surface waters drain into the lower elevations and form shallow lakes with large surface areas. Because of the volume change that takes place as a result of evaporation, the dissolved minerals in the lakes may be greatly concentrated. Several of these lakes contain water with a dissolved solids content in excess of 30,000 mg/l. The dissolved solids content consists almost entirely of sodium, bicarbonate, and chloride.

Coliform bacterial densities are generally low; however, the Silvies River below the town of Seneca currently exhibits undesirable coliform counts.

Ground Water

Table 120 summarizes available ground-water quality data for the communities of Burns and Seneca. The data indicate that the water is of adequate quality for most purposes.

Table 120 - Mineral Water Quality of Ground-Water Supplies, Subregion 12

		SiO_2	Fe	Ca	Mg	Na	HCO_3	SO_4	Cl	NO_3-N	Total Solids	Hard. $CaCO_3$	F	pH
Burns, Ore. (Well 1)	2/19/54	35	0.1	13.2	8.5	33	91	11.2	2.1	--	187	62	0.3	7.7
Seneca, Ore.	5/13/60	--	0.0	50.5	17.6	22	148	185	2.7	0.2	288	198	0.7	8.0

Treatment

No communities in the subregion presently treat water supplies.

Municipal

Approximately 5,850 persons, or 44 percent of the subregion's population, are served by municipal water systems. The Burns-Hines area uses 1.35 mgd of the total municipal requirement of 1.5 mgd.

Ground water is utilized by all municipal systems.

Industrial

The only major industrial water need is that of a lumber company at Hines, Oregon. The mill, which is the largest pine mill under cover in the United States, has a water need of 1.4 mgd.

Rural-Domestic

The rural-domestic water requirement, amounting to about 3.6 mgd, is larger than either the municipal or industrial use. Of this amount, about 0.7 mgd is utilized for the domestic population, and 2.9 mgd are needed for livestock watering.

FUTURE NEEDS AND MEANS TO SATISFY NEEDS

Population growth and industrial expansion are the primary factors that will determine the future water needs in Subregion 12.

The estimated population of 13,300 in 1965 is projected to increase to 21,300 by 2020. This represents an increase of 60 percent, compared with a regional increase of 121 percent. The projected municipal and rural population figures for the years 1980, 2000, and 2020 are shown in table 121. By the end of the projection period, 77 percent of the population in the subregion will be using municipal water distribution systems as compared with 45 percent at the present time.

Table 121 - Projected Population, Subregion 12

	1980	2000	2020
	Thousands		
Municipal	9.0	12.4	16.3
Rural	7.3	6.3	5.0
Total	16.3	18.7	21.3

Production growth of the major water-using industries is projected to increase only 13 percent between now and 2020 in terms of value added. Lumber production will continue to be the major industry.

Municipal

Basis for Water Supply Projections

The population projected to be served by municipal water distribution systems is shown in table 121. The projected municipal water requirements are based on population projections and on per capita water needs presented in the "Future Needs" section of the Regional Summary. The average per capita demand is expected to be 275 gallons per day by 1980, 295 by 2000, and 310 by 2020.

Subregion 12 is in Climatic Designation 2, as defined in the Regional Summary.

Projections of Water Supply Requirements

The anticipated municipal water requirements for the years 1970, 1980, 2000, and 2020 are given in table 122. Water use is expected to increase to 5.1 mgd by 2020. The municipal requirements will remain less than the rural-domestic needs during the projection period.

Table 122 - Projected Municipal Water Use, Subregion 12

	1970	1980	2000	2020
	MGD			
Total	1.8	2.5	3.7	5.1

Problems and Solutions

Because of insufficient data, problems and solutions are not discussed.

Industrial

The Edward Hines Lumber Company at Hines, Oregon, is the only company in the lumber and wood products industry in the subregion and is the major industrial water user. The growth projection for the industry is insignificant. The food products industry consists of a one-man meat market and a part-time canning operation during the tomato season. Although the growth index is large, the resultant water requirement is negligible. The growth indices are presented in table 123.

Table 123 - Industrial Growth Indices, Subregion 12

	1980	2000	2020
	(Base Year 1963 = 1.00)		
Food products	1.61	3.21	4.40
Lumber and wood products	1.04	1.04	1.07

Projected industrial water needs are presented in table 124 for the years 1980, 2000, and 2020.

Table 124 - Projected Industrial Water Use, Subregion 12

	1970	1980	2000	2020
	MGD			
Lumber and wood products	1.5	1.6	1.6	1.7
Others	-	-	-	-
Total	1.5	1.6	1.6	1.7

Problems and Solutions

Because of the limited amount of available water, no major water-using industries are expected to locate in the subregion. Future water requirement problems should be no different than those of today.

Rural-Domestic

Basis for Water Supply Projections

The population expected to rely on individual water systems is shown in table 121. The projections show that about 23 percent of the population will be depending on individual systems by 2020.

Based on assumptions presented in the "Future Needs" section of the Regional Summary, the expected water requirement for the rural population will be 165 gpcd in 1980, 205 gpcd in 2000, and 250 gpcd in 2020.

The projected livestock population in the subregion is based on data presented in Appendix VI. It has been assumed for purposes of this study that the livestock water use per animal will remain constant during the projection period.

Projections of Water Supply Requirements

Anticipated rural-domestic water requirements are presented in table 125 for the years 1970, 1980, 2000, and 2020. The rural-domestic need is forecast to increase to 6.9 mgd by 2020; of this amount, 1.2 mgd will be required for domestic purposes and 5.7 mgd for livestock watering.

Table 125 - Projected Rural-Domestic Water Use, Subregion 12

	1970	1980	2000	2020
	MGD			
Domestic	1.1	1.2	1.3	1.2
Livestock	2.8	3.2	4.3	5.7
Total	3.9	4.4	5.6	6.9

Problems and Solutions

Problems and solutions are not enumerated because of insufficient information regarding the subregion.

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GLOSSARY

ACRE-FOOT - 43,560 cubic feet or 325,851 gallons.

AQUIFER - A geologic formation that is water-bearing and that transmits water from one point to another.

BOD (Biochemical Oxygen Demand) - The quantity of oxygen utilized in the biochemical oxidation of organic matter in a specified time and at a specified temperature. It is not related to the oxygen requirements in chemical combustion, but is determined entirely by the availability of the material as a biological food and by the amount of oxygen utilized by the micro-organisms during oxidation.

CFS (Cubic Foot per Second) - A unit of discharge for measurement of flowing liquid equal to a flow of one cubic foot per second past a given section. Also called second-foot.

COD (Chemical Oxygen Demand) - The quantity of oxygen utilized in the chemical oxidation of organic matter. It is a measure of the amount of such matter present.

CHLORINATION - The application of chlorine to water, sewage, or industrial wastes generally for the purpose of disinfection, but frequently for accomplishing other biological or chemical results.

COLIFORM BACTERIA - A species of genus escherichia bacteria, normal inhabitant of the intestine of man and all vertebrates.

COMPLETE TREATMENT - Coagulation, sedimentation, filtration, and disinfection.

CURIE - A unit quantity of any radioactive species in which 3.7×10^{10} disintegrations occur per second.

DO (Dissolved Oxygen) - The oxygen dissolved in sewage water or other liquid, usually expressed in milligrams per liter or percent of saturation.

EFFLUENT - Sewage, water, or other liquid which is partially or completely treated or in its natural state, as the case may be, flowing out of a reservoir, basin, or treatment plant or part thereof.

EUTROPHICATION - The process of overfertilization of a body of water by nutrients which produce more organic matter than the self-purification processes can overcome.

GPD - Gallons per day.

GPCD - Gallons per capita per day.

HARDNESS - A characteristic of water; chiefly due to the existence therein of the carbonates and sulfates and occasionally nitrates and chlorides of calcium, iron, and magnesium; which causes "curdling" of the water when soap is used, increased consumption of soap, deposition of scale in boilers, injurious effects in some industrial processes, and sometimes objectionable taste in the water. It is commonly computed from the amounts of calcium and magnesium in the water and expressed as equivalent calcium carbonate.

HYDROGEN ION CONCENTRATION - The weight of hydrogen ions in grams per liter of solution. Commonly expressed as the pH value that represents the logarithm of the reciprocal of the hydrogen ion concentration.

JTU (Jackson Turbidity Units) - The JTU, as the name implies, is a measurement of the turbidity, or lack of transparency, of water. It is measured by lighting a candle under a cylindrical transparent glass tube and then pouring a sample of water into the tube until an observer looking from the top of the tube cannot see the image of the candle flame. The number of JTU's varies inversely with the height of the sample (e.g. a sample which measures 2.3 cm has a turbidity of 1,000 JTU's whereas a sample measuring 72.9 cm has a turbidity of 25 JTU's).

MGD - Millions of gallons per day. A flow of one mgd for one year equals 112 acre-feet. Also one mgd equals 1.597 cfs.

MG/l - Milligrams per liter.

MPN (Most probable number) - In the testing of bacterial density by the dilution method, that number of organisms per unit volume which, in accordance with statistical theory, would be more likely than any other possible number to yield the observed test result or which would yield the observed test result with the greatest frequency. Expressed as density of organisms per 100 ml.

MAJOR SERVICE AREA - Arbitrarily selected service areas containing significant portions of the region's population and industry--Seattle, Tacoma, Everett, Portland, Salem, Eugene-Springfield, and Spokane.

OBE - Office of Business Economics.

PICOCURIE - 10^{-12} curies.

pH - See Hydrogen ion concentration.

RUNOFF - That part of rainfall or other precipitation that reaches watercourses or drainage systems.

SALINITY - The relative concentration of salts, usually sodium chloride, in a given water sample. It is usually expressed in terms of the number of parts per thousand of chlorine (Cl). Parts per thousand = o/oo.

SEDIMENT - (1) Any material carried in suspension by water which will ultimately settle to the bottom after the water loses velocity. (2) Fine waterborne matter deposited or accumulated in beds.

SERVICE AREAS - An area described for planning purposes whose boundaries would include the future population or industrial activities which could logically and functionally obtain water supply and waste disposal services from a central or integrated system or where the problems are so interrelated that the planning should be done on an integrated basis.

TDS - Total dissolved solids.

TURBIDITY - (1) A condition of a liquid due to a fine visible material in suspension which may not be of sufficient size to be seen as individual particles by the naked eye, but which prevents the passage of light through the liquid. (2) A measure of fine suspended matter (usually colloidal) in liquids.

TYPE 2 STUDY - Studies of feasibility or survey scope for individual river basins, tributary basins, or subregions.

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